Research Report 327

Juha Nieminen

Dimensions of University Student Learning in Medicine and Pharmacy

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Abstract

Study orientations in higher education consist of various dimensions, such as approaches to learning, conceptions of learning and knowledge (i.e. epistemologies), self-regulation, and motivation. They have also been measured in different ways. The main orientations typically reported are reproducing and meaning orientations.

The present study explored dimensions of study orientations, focusing in particular on pharmacy and medicine. New versions of self-report instruments were developed and tested in various contexts and in two countries. Furthermore, the linkages between study orientations and students' epistemological development were explored. The context of problem-based (PBL) small groups was investigated in order to better understand how collaboration contributes to the quality of learning.

The participants of Study I (n=66) were pharmacy students, who were followed during a three-year professionally oriented program in terms of their study orientations and epistemologies. A reproducing orientation to studying diminished during studying, whereas only a few students maintained their original level of meaning orientation. Dualism was found to be associated with a reproducing orientation. In Study II practices associated with deep and surface approaches to learning were measured in two differing ways, in order to better distinguish between what students believed to be useful in studying, and the extent to which they applied their beliefs to practice when preparing for examinations. Differences between domains were investigated by including a sample of Finnish and Swedish medical students (n=956) and a Finnish non-medical sample of university students (n=865). Memorizing and rote learning appeared as differing components of a surface approach to learning, while understanding, relating, and critical evaluation of knowledge emerged as aspects of a deep approach to learning. A structural model confirmed these results in both student samples. Study III explored a wide variety of dimensions of learning in medical education. Swedish medical students (n=280) answered the questionnaire. The deep approach to learning was strongly related to collaboration and reflective learning, whereas the surface approach was associated with novice-like views of knowledge and the valuing of certain and directly applicable knowledge. PBL students aimed at understanding, but also valued the role of memorization. Study IV investigated 12 PBL tutorial groups of students (n=116) studying microbiology and pharmacology in a medical school. The educational application was expected to support a deep approach to learning: Group members' course grades in a final examination were related to the perceived functioning of the PBL tutorial groups. Further, the quality of cases that had been used as triggers for learning, was associated with the quality of small group functioning.

New dimensions of study orientations were discovered. In particular, novel, finer distinctions were found within the deep approach component. In medicine, critical evaluation of knowledge appeared to be less valued than understanding and relating. Further, collaboration appeared to be closely related to the deep approach, and it was also important in terms of successful PBL studying. The results of the studies confirmed the previously found associations between approaches to learning and study success, but showed interesting context- and subgroup-related differences in this respect. Students' ideas about the nature of knowledge and their approaches to learning were shown to be closely related. The present study expanded our understanding of the dimensions of study orientations, of their development, and their contextual variability in pharmacy and medicine.

Keywords: student learning , approaches to learning, study orientations, learning strategies, personal epistemology, grades, higher education, small-group learning, problem-based learning (PBL), medical students

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Juha Nieminen

Lähestymistapoja oppimiseen ja opiskeluun lääketieteessä ja farmasiassa

Tiivistelmä

Yliopisto-opiskelijoiden opiskeluorientaatiot koostuvat useista osatekijöistä: lähestymistavoista oppimiseen, oppimis- ja tietokäsityksistä (epistemologiat), oppimisen säätelytavoista sekä motivaatiosta. Opiskeluorientaatioita on mitattu monin eri tavoin. Merkitysorientaatio ja tietoa toistava orientaatio ovat näistä vakiintuneimmat ja laajimmin tunnetut.

Opiskeluorientaatioiden osatekijöitä tutkittiin erityisesti farmasian ja lääketieteen opiskelijoilla. Aiemmin käytössä olleista mittareista kehiteltiin uusia versioita, joita testattiin erilaisissa opiskeluympäristöissä ja kahdessa eri maassa. Lisäksi tutkittiin opiskeluorientaatioiden ja opiskelijoiden episteemisen kehityksen välisiä suhteita. Opiskeluympäristöistä tutkittiin tarkemmin ongelmalähtöistä pienryhmäopiskelua sen selvittämiseksi, miten yhteisöllinen opiskelu tukee laadukasta oppimista.

Ensimmäisessä osatutkimuksessa farmasian opiskelijoiden (n=66) opiskeluorientaatioita ja episteemisiä käsityksiä seurattiin kolmivuotisten ammatillisesti orientoituneiden opintojen ajan. Tietoa toistava orientaatio väheni opintojen loppuun mennessä, mutta vain pieni osa opiskelijoista kykeni samalla ylläpitämään merkitysorientoituneisuuttaan. Dualismi oli yhteydessä tietoa toistavaan orientaatioon. Toisessa osatutkimuksessa pinta- ja syväsuuntautuneisuuteen liittyviä opiskelutapoja mitattiin kahdella eri tavalla, jotta voitaisiin paremmin erottaa missä määrin opiskelijat pitävät pinta- ja syväsuuntautuneisuuteen liittyviä opiskelutapoja hyödyllisinä ja missä määrin he soveltavat niitä käytäntöön valmistautuessaan tentteihin. Opiskelualojen välisiä eroja päästiin tutkimaan suomalaisilla ja ruotsalaisilla lääketieteen opiskelijoilta (n=956) sekä kolmesta muusta tiedekunnasta kerätyn aineiston (n= 865) avulla. Yksityiskohtainen muistaminen ja ulkoa opettelu muodostivat erilliset pintasuuntautuneisuuden osatekijät. Syväsuuntautuneisuus puolestaan rakentui pyrkimyksestä ymmärtää, yhdistää tietoa sekä tiedon kriittisestä arvioinnista. Rakenneyhtälömalli vahvisti tulokset molemmissa opiskelijajoukoissa. Kolmas osatutkimus tarkasteli useita opiskelun ulottuvuuksia ruotsalaisilta lääketieteen opiskelijoilta kerätyssä aineistossa (n=280). Syväsuuntautuneisuus oli yhteydessä yhteistyön ja reflektion arvostamiseen. Pintasuuntautuneisuus puolestaan yhdistyi mustavalkoisiin tietokäsityksiin ja suoraviivaisen soveltamisen arvostamiseen. Ongelmalähtöisesti opiskelevat pyrkivät ymmärtämään oppimaansa, mutta pitivät myös yksityiskohtien tarkkaa muistamista tärkeänä. Neljännessä osatutkimuksessa selvitettiin 12 ongelmalähtöisen pienryhmän toimivuutta biokemian ja farmakologian kurssilla (n=116). Opiskeluryhmän menestys kurssin loppukuulustelussa oli yhteydessä ryhmätoiminnan laatuun. Ryhmätoiminnan laatu oli myös läheisessä yhteydessä virikkeinä käytettyjen tapausten toimivuuteen.

Väitöskirjatutkimuksessa löydettiin opiskeluorientaatioista uusia ulottuvuuksia, erityisesti tarkempia erotteluja syväsuuntautuneisuudessa. Lääketieteessä tiedon kriittinen arviointi koettiin hieman vähemmän tärkeäksi kuin pyrkimys ymmärtää ja yhdistää tietoa kokonaisuuksiksi. Yhteistyö oli yhteydessä syväsuuntautuneisuuteen ja ongelmalähtöisen pienryhmäopiskelun tuloksellisuuteen. Tutkimusten tulokset vahvistivat aikaisempia käsityksiä lähestymistapojen ja opiskelumenestyksen välisistä yhteyksistä, mutta osoittivat näissä myös kiinnostavia tilanne- ja alaryhmäkohtaisia eroja. Opiskelijoiden tietokäsitykset ja lähestymistavat oppimiseen olivat yhteydessä toisiinsa. Väitöskirjatutkimus laajentaa käsitystämme opiskeluorientaatioiden ulottuvuuksista, näiden kehittymisestä ja tilannekohtaisesta vaihtelusta farmasiassa ja lääketieteessä.

Avainsanat: lähestymistavat oppimiseen, opiskeluorientaatiot, opiskelustrategiat, tietokäsitykset, arvosanat, pienryhmäopiskelu, ongelmalähtöinen opiskelu, lääketieteen opiskelijat, yliopisto-opiskelijat

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Helsinki, May 2011
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List of original publications

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals (Studies I-IV):

I Nieminen, J., Lindblom-Ylänne, S. & Lonka, K. (2004). The development of study orientations and study success in students of pharmacy. *Instructional Science*, 32, 387-417.

II Nieminen, J., Lonka, K., Heikkilä, A., Lindblom-Ylänne, S., Loyens, S. (submitted). What Are We Really Measuring When Investigating Approaches to Learning? The Distinction between Perceived Importance and Actual Application.

III Lonka, K.; Parvaneh, S., Karlgren, K., Masiello, I., Nieminen, J., Birgegård, G. & Josephson, A. (2008). MED NORD - A tool for measuring medical students' well-being and study orientations. *Medical Teacher*, 30, 72-79.

IV Nieminen, J., Sauri, P. & Lonka, K. (2006). On the relationship between group functioning and study success in PBL. *Medical Education*, 40, 64-71.

Contents

1. Introduction

1.1 The SAL tradition of research

Since the 1970s, a line of research has investigated how students differ in the ways they view and approach learning. This research tradition has become known as Student Approaches to Learning (SAL). Investigators in the SAL tradition have sought to describe and measure how students go about learning and how differences in approach relate to the quality of learning. 'Study orientation' is a central concept the SAL tradition, bringing together several components, such as approaches to learning, conceptions of learning and knowledge (i.e., epistemologies), self-regulation, and motivation. The two main orientations most commonly investigated are reproducing and meaning orientations.

The SAL tradition of research originated in investigations of social science students' ways studying texts and writing (Entwistle & McCune, 2004). Although research has since been conducted in multiple domains and settings, the focus of the present dissertation is to understand what meaning-oriented learning entails in such natural science fields as medicine and pharmacy. Some dimensions of student learning may be more central in such professionally-oriented domains of natural science than in other fields, where ill-defined problems are analyzed from early on. Typical of natural science professions is to start by studying very complex and detailed knowledge from biomedical research, and to gradually turn this knowledge into practical or clinical understanding. Such forms of expertise may call for quite special ways of learning.

Students' ideas about what scientific knowledge is like may develop differently in various domains. What is considered to be useful and important in studying may be somewhat different in fields such as humanities from that in pharmacy and medicine. Finally, various contexts, tasks, and assessment systems may be differently associated with students' study orientations and their relationship to study success.

Study orientations and their constituents have been measured in several ways, and at differing levels of complexity. When investigating something as varied and multidimensional as student learning, it is impractical to try to take all important contextual and individual variation into account at one time. Yet it is also easy to forget that one's conceptual systems necessarily oversimplify the complex field in which students orient themselves.

The present study seeks to enrich understanding of the dimensions and contextual variability of study orientations, particularly in the professionally- or application-oriented natural sciences of pharmacy and medicine (Lonka & Lindblom-Ylänne, 1996; Lonka, Olkinuora, & Mäkinen, 2004). In addition, the interface where a student's predispositions and educational interventions meet is explored by investigating the quality of problem-based small group learning and its associations with study success.

1.1.1 Approaches to learning

In the mid 1970's, the Gothenburg group conducted seminal studies on the various ways students may approach learning tasks (Marton & Säljö, 1976a; Marton & Säljö, 1976b; Svensson, 1976). Marton and Säljö (1976a; 1976b) gave a group of university students a text to read and told them they would later be questioned on it. Subsequently, students were tested on how they had understood the text and questioned on how they had gone about reading it.

Marton and Säljö found that students had approached the task with differing intentions. Some students had intended to understand what the author had meant, while others had sought to commit text into memory as such, in order to be later able to reproduce it. In other words, some students had sought to understand the text while others bypassed understanding, trying to commit knowledge to memory with minimal processing. Students with an intention to understand had processed the material by comparing and structuring ideas into comprehensible wholes, and by critically evaluating knowledge and conclusions presented by the author. The students whose intention had been to commit parts of text to memory had concentrated on only some isolated aspects of the text, seeking to commit to memory the parts of the text that might be useful in the subsequent test. The former combination of intentions and processing strategies became eventually known as a 'deep approach' to learning, and the latter, a reproduction-focused one, as a 'surface approach' to learning (Marton, Hounsell, & Entwistle, 1997). As it turned out, the students who had described adopting a deep approach also showed qualitatively better learning outcomes (Marton & Säljö, 1984).

SAL takes form – early questionnaires

The concepts of deep and surface were soon incorporated into questionnaires measuring student motivation and learning (Biggs, 1979; Biggs, 1987; Entwistle, Hanley, & Hiounsell, 1979; Entwistle & Ramsden, 1983). The two early ques-

tionnaires *Approaches to Studying Inventory* (ASI, Entwistle & Ramsden, 1983) and the *Study Process Questionnaire* (SPQ, Biggs, 1979) measured students' intentions (ASI) or motivations (SPQ), and the learning processes associated with them. The term 'approach' was adopted to refer to both the intention/motivation and the processes linked with it (Entwistle et al., 1979). 'Deep approach' and 'surface approach' to learning have become standard terminology in research literature.

The deep approach has typically been measured as a student's intention to understand content, together with the processes of relating and structuring ideas and checking conclusions against evidence (Entwistle, 2007; Lonka & Lindblom-Ylänne, 1996; Marton & Säljö, 1976a; Vermunt, 1998). A surface approach to learning has been defined as an intention to reproduce content, with learning processes characterized by syllabus-boundness, rote learning, and attempts to commit information to memory without making connections between pieces of knowledge. It should be kept in mind that, unlike the qualitative studies investigating students' approaches to a particular task in a particular situation, in questionnaires students report how they typically approach learning situations, as if cumulated over several actual instances of studying; consequently they may to a large extent measure approaches at the level of dispositions (for more thorough discussions, see Biggs, Kember, & Leung, 2001; Entwistle & McCune, 2004; Lonka, 2004; Pintrich, 2004).

Regulation of learning as an element of approaches to learning

The question of how students regulate their own learning runs through the theory of student approaches to learning. It was already present in the perspective taken by Marton and Säljö (1976a; 1976b), when they categorized descriptions of what students intended to do and how they pursued their intentions when reading a text. Questionnaires have also, from their early versions, included elements measuring what motivates students and how students direct their learning and studying.

Vermunt (Vermunt, 1996; Vermunt, 1998; Vermunt & Verloop, 1999) made an explicit effort to integrate research on SAL and the predominately North American research on the regulation of learning (see also, Boekaerts, 1997; Pintrich, 2004). He created scales to measure how the responsibility for deciding what, how, and when to study, is divided between the learner and the learning environment (Vermunt, 1996; Vermunt, 1998; Vermunt & Verloop, 1999). In Vermunt's model, a student who prefers to plan, monitor, and adjust the learning process him/herself is designated as self-regulating whereas a student who relies on teachers, peers, or study materials for guidance exhibits external regulation

of learning. A student showing lack of regulation is confused about how she or he should study (Vermunt, 1998).

The deep approach has been shown to be related to the readiness of students to regulate their own learning processes (Lonka & Lindblom-Ylänne, 1996; Vermunt & Vermetten, 2004). Vermunt has proposed that the monitoring and regulation of practical study strategies is an important link between what a student believes to be essential and important about learning and the concrete processing strategies he or she employs while studying.

1.1.2 Conceptions of learning and knowledge

Conceptions of learning

Students' approaches to learning are associated with their more general ideas about what sort of activity learning is (Entwistle, 2007; Vermunt, 1998). Säljö (1979) found five ways to understand the nature of learning, ranging from reproductive descriptions of learning to more reconstructive ones.

1. Learning as the increase of knowledge
2. Learning as memorizing
3. Learning as the acquisition of facts and procedures
4. Learning as the abstraction of meaning
5. Learning as an interpretive process aimed at the understanding of reality

Marton et al. (1993) conducted a series of interviews and found five conceptions which were highly similar to those described by Säljö, and also a sixth one, which they named 'changing as a person'. 'Changing as a person' seems to refer to a more integrative process, where a student considers the wider implications of what she or he is learning. Lonka (1997) related this category of learning to 'wisdom' "as a form of integrated and mature thought" (p. 81). Vermunt's mental models of learning (Vermunt, 1998), more global in scope, are in many ways similar to conceptions of learning. His mental model 'intake of knowledge' is very similar to the reproductive conceptions in Säljö's categorization, whereas Vermunt's mental model 'construction of knowledge' emphasizes the abstraction of meaning and the quest for understanding, much like Säljö's reconstructive conceptions of learning.

By now, ample evidence shows that students' approaches to learning are, indeed, linked with what they believe about the nature and purpose of learning (Boulton-Lewis, 2004; Cano, 2005a; Lonka, Joram, & Bryson, 1996; Loyens,

Rikers, & Schmidt, 2007; Marton et al., 1993; Säljö, 1979; Vermetten, Vermunt, & Lodewijks, 1999). A connection has been shown between Säljö's conceptions of learning and approaches to learning (van Rossum & Schenk, 1984). Likewise, Vermunt's intake of knowledge has been shown to be associated with a surface approach to learning and construction of knowledge to a deep approach (Loyens et al., 2007; Loyens, Rikers, & Schmidt, 2008; Richardson, 2010; Vermunt, 1998). Recently, Edmunds and Richardson (2009) used a large sample of students from 15 departments to confirm the link between students' conceptions of leaning and their approaches to studying. Examples of seemingly conflicting combinations of conceptions and strategies have, however, also been found (Cano, 2005a), for example, when students voice conceptions that are more sophisticated than the strategies they use (Boulton-Lewis, Wilss, & Lewis, 2003; Boulton-Lewis, Marton, Lewis, & Wilss, 2004).

Conceptions of knowledge

Parallel to studies on conceptions of learning, another line of research has investigated students' beliefs about the nature of knowledge, referred to as conceptions of knowledge, or epistemologies (Hofer & Pintrich, 1997; Hofer, 2000; Lonka, Lindblom-Ylänne, Nieminen, & Hakkarainen, 2001; Paulsen & Feldman, 2007; Perry, 1968; Perry, 1970; Ryan, 1984; W. A. Sandoval, 2005; Schommer, 1990). Perry (1968; 1970) presented a multi-level developmental continuum of epistemological beliefs starting from dualistic views of knowledge. A student with dualistic conceptions of knowledge perceives knowledge as a set of clear, absolute, and unchanging facts, which can be verified by appropriate authorities. In Perry's (1968; 1970) developmental model, students (who in his seminal study were male students from Harvard University) would typically develop towards a more relativistic view of knowledge. For a relativist, knowledge is subject to change. A relativist would hold that knowledge is created and evaluated in a specific context and can be both supported and criticized by presenting relevant evidence and arguments. At the most advanced level, a student is capable of evaluating relevant evidence and arguments, and based on such analyses, of committing to personal views. Since Perry's seminal studies, several lines of research have examined epistemological development from slightly differing perspectives and with various methodologies (Baxter Magolda, 1992; Hofer & Pintrich, 1997; Schommer, 1990).

Schommer (1990; 1993) suggested that there was more than one dimension to epistemological beliefs and that an individual may be at different points on those dimensions. Schommer's five epistemological dimensions included sim-

ple knowledge, certain knowledge, quick learning, fixed ability, and source of knowledge. Hofer and Pintrich (1997; 2000) compared several lines of previous research and suggested that there were two main dimensions in students' personal epistemologies: beliefs regarding the nature of knowledge and beliefs regarding the process of knowing. Each of these dimensions could be further divided into two constituent sub-dimensions. Hofer and Pintrich only included beliefs that are directly related to the nature of knowledge and knowing, leaving other related conceptions, such as conceptions about the nature of learning, out of their theoretical model (Hofer & Pintrich, 1997; Hofer, 2001).

According to Hofer and Pintrich's model (1997), which is based on an extensive review of theoretical and empirical research, a student with dualistic views of the nature of knowledge believes that knowledge is certain, fixed and unchanging, consisting of discrete, simple facts that can be quantitatively accumulated. Alternatively, a student with more sophisticated epistemological beliefs would view knowledge as tentative, evolving, and as being determined by its relationship to surrounding concepts and contexts. Regarding the process of knowing, a highly dualistic student might view external authorities as valid sources of knowledge, and rely on them (and sometimes even just personal feelings) to justify knowledge. Alternatively, a student with a more academically sophisticated view of the process of knowing would see it as a process of construction, in which rules of inquiry are used to evaluate and integrate differing views. Hofer and Pintrich show laudable conceptual clarity in their effort to integrate central findings of a diverse body of epistemological research.

Not only can epistemological development be seen as a valid goal of education in and of itself, research also indicates that a dualistic epistemology is linked to a poorer quality of learning, while more sophisticated epistemological beliefs are associated with superior learning outcomes (Kardash & Scholes, 1996; Quian & Alvermann, 1995; Schommer, 1990; Schommer, Crouse, & Rhodes, 1992; Schommer, 1993; Schommer & Walker, 1995). The pattern of results concerning epistemological beliefs and study success may not, however, be stable across contexts and cultures (Hofer, 2008; Zhang & Watkins, 2001).

Conceptual perspectives into orientations and epistemologies

Considerable diversity can be found in the ways conceptions of learning and knowledge and their mutual relationships are defined in the literature. A large part of the literature on student epistemologies does not make a clear distinction between the two categories of beliefs. Both are seen as belonging to the category of epistemological beliefs, which influence learning processes and out-

comes (Schommer, 1990; Tolhurst, 2007). In models of self-regulated learning, students' epistemological beliefs and dispositions to learning are often posited as an instance of metacognitive beliefs, which moderate how students monitor and control learning (Bråten & Strømsø, 2005; Paulsen & Feldman, 2007; Phan, 2008; Winne, 1996).

Hofer and Pintrich (1997; Hofer, 2001) advocated keeping the two categories conceptually separate and called for more empirical research to establish how the two types of beliefs are related to each other. Based on their theoretical standpoint, they pointed out that two of Schommer's epistemological dimensions, "quick learning" and "fixed ability", refer to what students' believe about learning, and should therefore not be regarded as aspects of personal epistemologies. Hofer and Pintrich's position seems well warranted from the point of view of theoretical clarity and conceptual precision.

However, when viewed from the perspectives of a) the practice of studying, and b) students' descriptions of how they understand learning and knowledge, the two categories of beliefs appear to be very closely related to each other or even inseparably intertwined (Elby, 2009). Furthermore, the two categories of conceptions have similar connections with study-strategy use and learning outcomes (Lonka & Lindblom-Ylänne, 1996; Ryan, 1984; Schommer et al., 1992; Schommer & Walker, 1995; Vermunt, 1998). Entwistle (2007) described both kinds of conceptions as contributing to students' ability to recognize various forms of knowledge and learning processes. In his model, the most advanced levels of conceptions of knowledge and learning both contribute to a student's sense that learning results in changing as a person (i.e., the sense of identity).

Elby (2009) argued that while keeping conceptions of learning and knowledge theoretically separate from each other may bring clarity to a scattered field, it is too early to decide on the best solution until more empirical and theoretical progress is made. He suggested that if it turns out that the processes are, in practice, inseparably entangled with each other, it might be better to include views about the nature of learning under the general construct of 'epistemologies'. Sandoval (2009) countered Elby's argument by pointing out that maintaining the conceptual distinction between conceptions of learning and conceptions of knowledge does not exclude the possibility of studying the mutual relationships between the two categories of conceptions, but would, instead, enable real theoretical progress. Brownlee et al. (2002), in turn, has presented a holistic conceptualization of epistemological beliefs, where beliefs about knowing are seen as core beliefs, connected to most other beliefs and therefore being fairly resistant to change. In her model, beliefs about learning take a more peripheral place and are believed to be more easily affected by the learning environment. In effect, the theoretical model by Brownlee et al. seems to occupy a position in between

the two polarities of the discussion. A somewhat similar stance was taken by Lonka , Joram & Bryson (1996). Lonka (1997) argued: "Definitions of learning provide a window for looking at epistemologies, because they implicitly include conceptions of the origins of knowledge. Therefore conceptions of learning and knowledge are very hard to separate from each other" (p. 19).

Vermunt (Vermetten, Vermunt et al., 1999; Vermunt, 1996) intended his construct "mental models of learning" to cover a wide variety of students' conceptions: including those having to do with knowledge as well as those referencing learning, along with ideas about the roles of students and teachers in learning and studying. A student may, for example, believe that learning entails active transformation of meaning and construction of knowledge, as in Vermunt's mental model 'construction of knowledge' (Vermunt, 1998). From such a position, it would seem plausibly to follow that such a student would also see the student as the primary actor in learning and the teacher more as a mentor or facilitator of the process. A student's mental model of learning is thought to cover all of those aspects (Vermetten, Vermunt et al., 1999; Vermunt, 1996). Similarly, a student holding an 'intake of knowledge' model (Vermunt, 1998) conceives learning as a process of receiving and storing knowledge as it is presented by teachers or in study materials. Such a stance clearly mirrors dualistic beliefs about learning, according to which knowledge is objective and its value determined by external authority. The respective roles of students as fairly passive learners and teachers as authoritative dispensers of absolute knowledge would seem to be almost inseparable parts of the package. Vermunt's model could, therefore, be seen as congruent with Elby's conceptually inclusive arguments.

However, only few empirical studies have investigated how conceptions of learning are related to epistemologies. In a study of students of psychology and medicine (Lonka & Lindblom-Ylänne, 1996), dualistic conceptions of knowledge were found to be associated with a surface approach to learning, lack of regulation and external regulation of learning. Similarly, in a study of Chinese and U.S. university students (Zhang & Watkins, 2001), a dualistic way of thinking was related to a surface approach, whereas committed relativist thinking linked with a deep approach. Similar results were obtained by Cano in a sample of European secondary students (Cano, 2005b), whereas Crawford et al. (1994; 1998) have shown that a deep approach to studying mathematics is related to a cohesive conception of mathematics, whereas a surface approach is linked with a fragmented understanding of the nature of the discipline.

Based on interviews of part-time university students, Kember (2001) concluded that students' beliefs about knowledge, learning, and teaching are interrelated and can be described as two distinct belief orientations: a didactic/reproductive orientation, incorporating dualistic beliefs, and a facilitative/transformative ori-

entation, comprising relativist ideas about knowledge. More recently, Phan has confirmed such linkages between epistemological beliefs and study strategies using latent variable analyses (Phan, 2008).

Hofer and Pintrich (1997; Hofer, 2001; Pintrich, 2002) called for more research to conceptually clarify, and empirically investigate the linkages between epistemological beliefs, conceptions of learning, study strategies, and academic performance. More research is needed to see whether, along with mental models of learning, conceptions of knowledge could be regarded as components of study orientations.

1.1.3 Study orientations

In ASI (Entwistle & Ramsden, 1983) approaches to learning were linked with other variables, such as intrinsic motivation or fear of failure, to form second-order variables, which they called the 'meaning orientation' and the 'reproducing orientation' to studying. In subsequent research literature, such larger patterns (typically second-order constructs emerging from factor-analyses) of inter-related variables have been called "orientations to studying" or "study orientations".

Biggs's inventory SPQ (Biggs, 1979; Biggs, 1987) turned out to produce highly similar factors, which in later versions of the instrument were named according to Marton and Säljö's terminology as the "deep…" and "surface approaches to learning". Biggs did not adopt the term "orientation" to be used for his second-order factors, but has later stated that it might have been theoretically more coherent to do so (Biggs, 2001). Table 1 shows the two main orientations and related conceptions of learning and knowledge.

Table 1. Meaning orientation and reproducing orientation and their associations with epistemological concepts, based on SAL literature.

Component	Study orientation	
	Reproducing orientation	Meaning orientation
Approach to learning	Surface approach	Deep Approach
Mental model of learning	Intake of knowledge	Construction of knowledge
Regulation of learning	External regulation (Lack of regulation)	Self-regulation
Conception of knowledge i.e. Epistemology	Dualism Certain knowledge	Relativism

A variety of other orientations have also been introduced. Originally Entwistle and Ramsden proposed a third, 'strategic', orientation, characterized by an intention to achieve the highest possible grades through high effort, good management of time and working conditions, and by paying attention to lecturers' preferences and requirements of assessment. Biggs proposed a similar third construct built around the motive to succeed well in studies, called the 'achievement approach', associated with effective use of time and space.

The two main orientations have, however, proven to be empirically the most robust (Richardson, 1994; Richardson, 1997). They also seem to be theoretically in the same "ballpark", both referring clearly to students' relationship to the content that is being studied. Effective use of time and space, along with other aspects of high achievement – as important as they undeniably are – seem to refer to issues of a slightly different nature. On such grounds, both Biggs and Entwistle have, in later reformulations of their questionnaires, concentrated on the two main orientations, defining and measuring effective management of time and effort as separate constructs (Biggs et al., 2001; Entwistle, McCune, & Hounsell, 2003). In his model, Vermunt (1988; 1998) proposed two learning styles, the 'meaning-directed style' and the 'reproduction-directed style', that are very similar to the orientations and approaches introduced by Entwistle and Ramsden and Biggs,

although quite a bit more extensive in scope. Vermunt also put forward two additional styles, the 'undirected learning style', characterized by a lack of regulation in studying, and the 'application-directed learning style', emphasizing practically useful knowledge. The latter style resembles "professional orientation" (Lonka & Lindblom-Ylänne, 1996), or 'work-life orientation' (Mäkinen, Olkinuora & Lonka, 2004), both typical of Finnish medical students.

Study orientations, study success, and stress

The meaning orientation to studying has been repeatedly shown to be associated with better grades than the reproducing orientation (Nelson Laird, Shoup, Kuh, & Schwarz, 2008; Phan, 2009a; Watkins, 2001), including medical education (McManus, Richards, Winder, & Sproston, 1998), and appears to be better aligned with the qualitative aims of higher education (Biggs et al., 2001). Although a large body of quantitative research supports the connection between study orientations and study success, correlations have typically been rather small in magnitude (Watkins, 2001). Similar connections have been found between epistemological beliefs and qualitative aspects of the learning process (Hofer, 2001; Phan, 2009b) and with grades (Trautwein & Lüdtke, 2007), sophisticated epistemological beliefs being associated with good quality of learning. The extent to which a meaning orientation to learning leads to better achievement than a reproducing orientation depends on a number of contextual factors, such as the nature of assessments used in the educational program (Biggs, 1996; Gibbs & Simpson, 2005; Vermunt, 2005).

A surface approach to learning has also been associated with high levels of stress and poor emotional and cognitive regulation of learning (Heikkilä, Niemivirta, Nieminen, & Lonka, 2011; McManus, Keeling, & Paice, 2004). Some indications of this were already present in the early questionnaire research on SAL: The reproducing orientation was associated with text anxiety in the first versions of ASI (Entwistle & Ramsden, 1983).

Regarding medical education, evidence is open to doubt on whether medical students experience higher or even lower (Salmela-Aro & Kunttu, 2010) levels of stress than students from other fields (Robotham, 2008). It is clearly a part of the higher education experience for a segment of the student population. Dahlin, Joneborg & Runeson (2005) reported elevated levels of stress in Swedish medical students, especially women. Again, in a Scottish study, a subgroup repeatedly reported distress during their studies (Guthrie et al., 1998). As the negative consequences of exhaustion can be severe (Fahrenkopf et al., 2008) stress and other indications of distress should be further investigated in medical schools and other institutions of higher education.

1.2 Contextual variation in study orientations and epistemologies

The SAL tradition is founded on the idea that approaches to learning occur in relation the context in which studying takes place. For example, the nature of the content a student is working with, and the demands of the tasks he or she engages with, have an elemental role in shaping how he or she approaches the material (Entwistle & McCune, 2004). SAL thus represents a departure from perspectives that are more focused on stable characteristics of individuals (Biggs, 2001). The SAL perspective emphasizes that approaches and orientations are not to be understood as traits, such as persistent cognitive styles, but that they should be seen as changeable patterns of intentions and processes. Even when measured at the level of dispositions – tendencies to adopt certain kinds of intentions and processes – dispositions are expected to develop through interaction with learning environments (Biggs, 1993; Biggs, 2001; Entwistle & McCune, 2004).

Although the context-bound nature of approaches to learning may not have always been explicitly mentioned or strongly emphasized, it has been assumed since the early stages of SAL research. In one of the early and foundational articles, Entwistle, Hanley, and Hounsell (1979, p. 377) concluded: "It is in the possible interactions between students' approaches to learning, lecturers' styles of teaching, and disciplinary distinctiveness that the future of this research lies – and the possibilities of important implications for teaching and learning in higher education." A number of studies have since explored the many ways context and students' approaches to learning are interrelated (Diseth, 2007; Nijhuis, Segers, & Gijselaers, 2008; Scouller, 1998; Trigwell & Prosser, 1991; Vermetten, Vermunt et al., 1999). A variety of context-dependent patterns have, indeed, been found in empirical investigations of student learning.

1.2.1 Differences between disciplines

Considerable variation in students' approaches to learning is observed between academic disciplines (Kember, Leung, & McNaught, 2008; Nelson Laird et al., 2008; Vermunt, 2005). A commonly used typology of disciplines distinguishes between "soft" fields, such as the Arts, where even basic knowledge and the nature of scientific inquiry are constantly debated and "hard" fields, such as well-defined sciences, where academics agree on a large body of basic knowledge and where a relatively strong consensus about appropriate methods exists (Nelson Laird et al., 2008). This division represents a simplification of a categorization proposed by Biglan (1973) and reflects differences based on how strong and widely accepted

a paradigm exists in a given field, sciences typically exemplifying fields with a clear, unifying paradigm.

Students from Arts and other "soft" or more ill-defined disciplines tend to report higher levels of deep approach and lower levels of surface approach than students in "hard" disciplines (Booth, Luckett, & Mladenovic, 1999; Eley, 1992; Kember et al., 2008; Lonka & Lindblom-Ylänne, 1996; Nelson Laird et al., 2008; Parpala, Lindblom-Ylänne, Komulainen, Litmanen, & Hirsto, 2010; Ramsden & Entwistle, 1981). Similar discipline-related differences can be found in student's epistemological beliefs, as well. Students in hard fields tend to believe in the certainty of knowledge more than students in fields like humanities and social sciences (Jehng, Johnson, & Anderson, 1993; Kaartinen-Koutaniemi & Lindblom-Ylänne, 2008; Paulsen & Wells, 1998). In addition to the soft-hard continuum of academic fields, Biglan (1973) also introduced "concern with application" as a basis for categorizing domains. Paulsen and Wells (1998) found that it was the applied hard fields, such as engineering, where students reported the highest levels of belief in certain knowledge.

The categorization of fields into hard and soft is closely related to, even based on, the epistemological underpinnings of the fields themselves: whether practices in the field are typically based on the assumption that knowledge is certain or absolute (Biglan, 1973; Paulsen & Wells, 1998). Entwistle (2007) and others (Lonka et al., 1996; Lonka, 1997) argued that the differences between domains may, at least partially, give rise to the observed differences in students' epistemological beliefs. The predominance of ill-defined problems, and the contested nature of knowledge, may lead to somewhat different conceptualizations of relativism: even well-educated scholars from various fields may hold somewhat differing ideas about the nature of scientific knowledge (Entwistle, 2007). In the case of medicine, it needs to be kept in mind that the academic field consists of a wide variety of specialties, ranging from endocrinology and surgery to psychiatry, for instance. Specialties will often differ from one another in terms of methods of scientific inquiry and other epistemological underpinnings.

1.2.2 Differences between courses and tasks

Variance can, however, be found within students, as well. Students will adapt their approaches to suit the demands of differing courses, learning tasks, and assessment formats (Eley, 1992; Entwistle, McCune, & Walker, 2001; Nijhuis et al., 2008; Scouller, 1998; Vermetten, Lodewijks, & Vermunt, 1999). In some studies, researchers have instructed students to keep a certain course or a time-period in mind while filling in their responses (Kember et al., 2008; Vermetten et

al., 1999). In a few comparative studies of approaches to learning, the same group of students has been given two different versions of the same questionnaire, each version appropriated for a certain course or a specific assessment format (Eley, 1992; Scouller, 1998). When questionnaires were contextualized for two courses taken by the same group of students, it was found that many students did, indeed, modify their approaches to better suit the perceived requirements and teaching methods of the courses (Eley, 1992). Students were more likely to employ a deep approach when studying for assignment essays, which they perceived as measuring higher levels of cognitive processing (Scouller, 1998), than when studying for multiple choice assessment, perceived as measuring lower level intellectual processes. Such contextualized investigations have shown that approaches to learning do vary according to educational contexts and types of tasks.

1.3 Development of orientations and epistemologies in tertiary education

Vermunt & Verloop (1999) integrated theories of learning and teaching in their model of regulation and control over student learning. They called situations, in which a student's preferred level of control and teacher's way of structuring instruction meet in a balanced way, 'congruent'. In such a situation, a certain level of harmony between the student's wishes and the learning environment can be observed, but the student is not challenged to develop as a learner. When there is a discrepancy between the teacher's ways of teaching and the student's preferences for learning, 'friction' takes place. Friction can be constructive, if the learning environment encourages a student to develop as a self-regulated, meaning-oriented learner. Destructive friction may take place if a student experiences that the environment demands a more externally-regulated approach to learning than he or she would normally adopt. Another instance of destructive friction would be a situation where the constructive challenges of the environment are experienced as overwhelming and support is experienced as insufficient, resulting in frustration and discouragement. In such a situation, higher levels of educational support are called for, in order for the student to be able to rise up to the challenge and to develop a more meaning-directed, self-regulated way of studying. Vermunt and Verloop's model highlights some of the central processes through which students' approaches and orientations may improve or digress in interaction with the learning environment.

How much do approaches to learning, and study orientations, actually change during tertiary education? Based on evidence obtained with the ILS, Vermunt

and his colleagues concluded that learning strategies, the regulation of learning, mental models of learning and learning styles (as defined in ILS) are relatively stable, showing considerable consistency over time (Vermunt, 1998; Vermunt & Vermetten, 2004), although some changes do take place as students move between contexts (Vermetten et al., 1999) or progress in their studies (Vermetten, Vermunt et al., 1999). In a program specifically designed to encourage self-regulated learning, an increase in the study strategies associated with meaning orientation and a decline in the mental model intake of knowledge were found, but no simultaneous increase in construction of knowledge (Vermetten, Vermunt et al., 1999; Vermunt & Minnaert, 2003). They concluded that, overall, the changes that occur during tertiary studies are relatively small. Fox et al. (2001) came to a similar conclusion in a rare longitudinal study of a large sample of British medical students. They described approaches to learning as "partly modifiable" (Fox et al., 2001).

In some of the available longitudinal studies, the levels of deep approach to learning have been shown to decrease during tertiary studies (Tooth, Tonge, & McManus, 1989; Volet, Renshaw, & Tietzel, 1994; Watkins & Hattie, 1985). In a Dutch study (Busato, Prins, Elschout, & Hamaker, 1998) longitudinal data showed increasing levels of meaning orientation, but cross-sectional data did not. Australian science students' reproducing and meaning approaches changed very little over a three-year period (Zeegers, 2001). Longitudinal studies are relatively rare in the large body of published research on approaches to learning and orientations to studying.

Development of students' epistemological beliefs

Research into students' epistemologies has had a strong focus on the development of epistemological beliefs before and during tertiary studies (Hofer & Pintrich, 1997; Hofer, 2008). Overall, longitudinal evidence has indicated that students typically move towards more relativistic or constructivist conceptions of the nature of knowledge and of the process of knowing (Baxter Magolda, 1992; Perry, 1968; Perry, 1970), and that formal education is a strong formative factor (Pirttilä-Backman & Kajanne, 2001). Cross-sectional studies have provided additional evidence that advanced university students' hold more sophisticated epistemological beliefs than novices (Jehng et al., 1993; Lonka & Lindblom-Ylänne, 1996), although there are some exceptions, probably attributable to differences between cultures and educational systems (Zhang & Watkins, 2001). Educational interventions, such as collaborative knowledge building (Hong & Lin, 2010) and tasks that call for reflection (Hong & Lin, 2010), may enhance epistemological development in tertiary students. In medicine, problem-based learning (PBL) may

challenge students to tolerate uncertainty and ambiguity already from the beginning of studying and thereby have an impact on epistemological development. Thus far, there is no empirical evidence about this matter.

In addition, some evidence indicates that study orientations become more coherent as students progress through academic studies (Lindblom-Ylänne, 1999; Vermetten et al., 1999), although there may be temporary stages of confusion and incoherence of approaches related to frictions between students' dispositions and the demands of the teaching-learning environment (Vermunt & Minnaert, 2003).

Differing patterns of change in various subgroups of students

There is also some evidence that various groups of students may change differently even in the same environment. Lonka et al. (1996) found that novice-like students' conceptions of learning and knowledge showed the largest amount of change in a six-week follow-up study. Wilson and Fowler (2005) showed that students who had earlier reported high levels of surface approach increased their levels of deep approach during a course designed to promote deep learning, whereas students who had shown high levels of deep approach from the beginning did not change as a response to the intervention. Nijhuis et al. (2008) also found differences in the variability of approaches between subgroups of students: some students adapted to courses to a greater extent than others. However, these differences were unrelated to how deep or surface oriented the students generally were: Some students simply responded more strongly to the demands of the courses they were taking. Ropo (1993) showed that subgroups of students varied in how they reacted to experiences of poor instruction: Efficient students' appeared to be less vulnerable to the shortcomings of the learning environment than a less efficient subgroup of students. In a traditional medical curriculum, a small portion of students held onto a meaning-oriented way of studying even though they perceived the environment encouraging a surface approach to learning (Lindblom-Ylänne & Lonka, 1999; Lindblom-Ylänne & Lonka, 2001). Interestingly, it was the group of resistant students who also achieved the best grades.

Wilson and Fowler (2005) cautioned that looking solely at the main effects of differing environments on students' approaches to learning may lead one to overlook the differential influences of learning environment on subgroups of students. Longitudinal studies into the differing patterns of development are called for.

1.4 Theoretical and methodological choices

1.4.1 Conceptual and terminological variation in research on SAL

With the accumulation of evidence and the diversification of research instruments, a variety of related concepts and research methodologies have been adopted (for reviews, see Entwistle & McCune, 2004; Lonka et al., 2004; Richardson, 2004). Differing constructs have been included in questionnaires and grouped together in a variety of ways, to the point where an exhaustive explanation of how various concepts and their operationalizations are related to each other, has become impractical, if not completely impossible. In addition to variation in the definitions and scope of constructs, variability in terminology presents additional problems for even an advanced scholar of the field. Only the constructs most central to the present work are described here.

The deep and surface approaches to learning were originally called deep and surface 'processes', but soon became renamed 'approaches' in order to better describe the theoretical idea that students' intentions for a task were a central factor, guiding one to carry out processes that would serve the intention (Biggs, 2001; Entwistle & McCune, 2004). The term 'approach' reflects the context-bound nature of the concept: A student has an approach to a task within a context; processes are not expected to be intra-individual in nature (Biggs, 1996).

In ASI (Ramsden & Entwistle, 1981) the meaning and reproducing orientations to studying were introduced. The meaning orientation to studying had four subscales: deep approach, interrelating ideas, use of evidence, and intrinsic motivation, whereas the reproducing orientation consisted of surface approach, syllabus-boundness, fear of failure, and extrinsic motivation. These orientations were composed as second-order factors of the subscales and included learning related intentions, processes, and motivational and affective factors.

The SPQ (1987) covers much of the same ground as ASI's orientations, but they are called deep and surface approaches to learning. SPQ has separate motive and process subscales for the approaches. Biggs later argued (Biggs et al., 2001) that it might have been terminologically clearer to use the concept of "orientation" systematically for all questionnaire research measuring predispositions, and to have reserved the concept of "approach" to naturalistic, situated studies, such the ones conducted by Marton and Säljö in the '70's .

Both the ASI and the SPQ have gone through several revisions. The more recent instruments [Entwistle, LPQ (Entwistle et al., 2003); Biggs, SPQ-R (Biggs et al., 2001)] have settled on the two main approaches and use the terminology of deep and surface approaches to learning.

In Vermunt's ILS (Vermunt, 1998), the most concrete variables are the processing strategies which a student uses in order to learn the content she or he is studying. In Vermunt's model the processes "relating and structuring" and "critical processing" are related to each other and are together called "deep processing strategies", whereas "memorizing and rehearsing" together with analyzing (referring to a systematic method of processing details) form the group "Stepwise processing". The group "deep processing" comes conceptually very close to how a deep approach to learning is usually understood, and the group "stepwise processing" shares many of the elements of a surface approach to learning, without being fully interchangeable with it.

Vermunt's meaning-directed and reproduction-directed learning styles cover approximately the area as the two approaches of ASI and SPQ, but can be seen as an extension of them. Vermunt's inventory consists of scales measuring processing strategies, regulation of learning, mental models of learning, and learning orientations (referring to purposes of study, such as personal interest or certification). Vermunt's styles are, therefore, wide-reaching concepts describing how several aspects of learning relate to each other and shape how a student goes about studying.

Lonka and Lindblom-Ylänne (1996) also measured a large variety of phenomena with their Task booklet of Learning, which comprised selected scales from the ASI and ILS, but also direct measurements of epistemological beliefs (Perry, 1968; Ryan, 1984). Lonka and Lindblom-Ylänne computed second-order variables, which they named 'study orientations'. Two of their study orientations were highly similar to meaning and reproducing orientations. Both dualism and surface approach loaded on the latter.

Recently, Phan and colleagues (2009a) looked at the relationships between an even wider array of variable, such as study strategies, reflective thinking, epistemological beliefs, and goals. They were able to show similar relationships between concepts to those found in earlier research. The work of Heikkilä and colleagues (Heikkilä & Lonka, 2006; Heikkilä et al., 2011) pointed in the same general direction and represents an integration of several conceptually related lines of research. Their recent analyses are person-oriented instead of variable-oriented, and instead of using the concept of "orientations", profiles of student subgroups are constructed.

1.4.2 Issues of measurement

Pintrich (2004) used the metaphor of grain size to describe the differing levels at which one can measure student learning: from a very detailed analysis of what

goes on in specific learning situations to the more general approaches or orientations students typically adopt when studying. In a similar vein, Lonka et al. (2004) distinguished students' general study orientations from the more contextualized predispositions students may have regarding 1) a domain of study, 2) a specific course they are taking, or 3) a particular learning situation. In their questionnaire (MSLQ) Pintrich and his collaborators (Duncan & McKeachie, 2005; Pintrich, Smith, Garcia, & McKeachie, 1991) settled with the course level as a compromise between very general and overly detailed levels of measurement.

For a researcher, the existence of numerous related concepts presents a challenge: One is forced to make choices about which aspects to include within the same construct, how broadly or narrowly to define variables, and which distinctions to make. The choice of which variables should be included in a second-order variable, such as a study orientation or a style, is a theoretical question, as well as an empirical one. Empirically, one would be interested to see, how strongly differing elements of learning and studying are associated with each other. Correlations alone cannot, however, be the bases of theoretical and methodological choices. What one wishes to investigate should ultimately guide which variables one uses. Entwistle described the challenge as follows: "Theoretical constructs differ in their range and scope: some describe global concepts having wide generality, whereas others relate to a specific situation. These contrasting levels of description that have emerged in answer to different research questions are rooted in differing theoretical perspectives. In deciding which conceptual framework to adopt, both purpose and context have to be considered." (Entwistle et al. 2001, p. 103.) In some situations it may, thus, be informative to look at large constellations of variables and to postulate wide overarching orientations, whereas at other times it may be more useful to distinguish between closely related variables, and then examine the mutual relationships between distinct constructs.

Another interesting distinction concerns the question to what extent students base their ratings of questionnaire items on what they *actually do* when trying to learn, and to what extent on what they just *believe* to be good ways to study. Richardson argued that students' personal theories of learning and knowledge – and of themselves as learners – may influence how they respond to questionnaires measuring approaches to learning (Provost & Bond, 1997; Richardson, 2000). It may, thus, be difficult for students to distinguish between what they believe to be productive or socially acceptable ways of studying from what they actually do when studying. University students tend to value deep, personal understanding, as sometimes reflected in high ratings on items measuring such conceptions (Vermunt, 1998); however, students do not always act accordingly (Entwistle et al., 2001). There may be several different reasons underlying the discrepancy. Choices conflicting with preferences may be particularly likely when the learning

environment is perceived as encouraging surface processing (Boulton-Lewis et al., 2004; Cano, 2005a; Lindblom-Ylänne & Lonka, 1999; J. H. F. Meyer, 2000; J. H. F. Meyer & Boulton-Lewis, 1999).

Elby's study (1999) is an useful example of this. He first asked physics students to report how they study and then, through a case example, to report how a student who would not experience any grade pressure should study physics. He found that students perceived "trying to understand physics well" differently from "trying to do well in the course". Many students believed that deep learning would not be enough to do well in course and reported more use of rote learning in the situation of studying for a course than in a pressure-free context. For a student who does not need to do well in a course, the participants recommended aiming for a deep understanding of concepts and the analysis of real-life examples. Elby´s (1999) study nicely demonstrated how students' views on learning, and their reported approaches to learning, change when probed from the perspective of differing contexts.

The questionnaire items used to measure approaches to learning typically measure what students do or intend to do when studying, for example: "I try to make sense of things by linking them to what I know already" (LSQ, Entwistle, McCune, & Hounsell, 2002) , "I test myself on important topics until I understand them completely" (R-SPQ-F, Biggs et al., 2001)" or "I try to be critical of the interpretations of experts" (ILS, Vermunt, 1998) It is often unclear to what extent results reflect what students believe about learning and studying – how they feel they should ideally be studying – and to what extent how they operate in real life learning situations. When measuring approaches to learning, it might be fruitful to try to tease out the distinction between what types of processes students think are important in learning on the one hand, and how much they apply those practices to different contexts of studying, on the other.

Furthermore, a researcher should seek to specify 1) whether the aim is to measure students' beliefs about what kinds of practices are useful in university learning or their dispositions to employ those practices in actual learning situations, and 2) whether one wishes to measure dispositions over several differing contexts and situations, or to concentrate on more precisely defined situations, such as particular university courses or types of learning tasks.

Such specifications can be made when statements are formulated for instruments (e.g., in general or in context-specific ways) and when directions for respondents (e.g., what kinds of courses to keep in mind when rating statements) are delineated. Choices of from whom to collect data and how to analyze it are equally important. For some purposes, aggregating several variables into large orientations and analyzing them across contexts may be warranted. At other times the investigation of tightly defined variables, or comparisons between small subsets of cohorts, may be more useful.

When contextualizing the measurement to preparing for examinations, the demands of the assessment system could be expected to be activated for the respondents (Elby, 1999). Students might base their answers more on the practices that are typical in their current educational context, and perhaps somewhat less on their general beliefs about what kinds of learning processes useful in learning. Thus measured, we would expect students to recognize that their typical behavior differs from what they generally believe about learning. When contextualized to preparing for examinations, the means of deep approaches to learning could be expected to be lower and the means for surface approaches higher than they would be if measured at the level of beliefs.

It would also be interesting to explore whether reliabilities of scales could be improved as a consequence of the respondents having a more clearly defined context in mind. It might be expected that when a context is loosely specified, there would be more room for varied interpretations of items and therefore less coherence in the way students would respond to questionnaire items. It is, however, difficult to make clear predictions about how keeping such a situation in mind would influence the interpretation of items and the resulting scale coherence.

In the present work, differing levels of description and measurement are adopted. For some purposes, wide constellations of variables are organized into over-arching orientations in order to examine how aspects of learning and studying are related to each other in students of natural science. At other times, fine distinctions between closely related phenomena are teased out, in order to fine-tune instruments to detect variance that is otherwise easily overlooked.

1.5 Promoting deep approaches to learning in medical education

Faced with the widely acknowledged shortcomings of medical education as fact laden and tending to promote a surface, rather than a deep approach to learning (Bullimore, 1998, p. 47; Lindblom-Ylänne & Lonka, 2001), the medical education community has looked for ways to make medical education more conducive to high quality learning, and to provide a humane, interactive environment, particularly for the first two years of medical training (premedical studies).

Problem-based learning is a well-known educational approach that has been adopted by medical schools as an effort to alleviate the abovementioned educational problems (Wood, 2003). Although implementations of PBL differ from each other considerably (Maudsley, 1999), some features are generally considered as typical and defining of a PBL program (Dolmans, De Grave, Wolfhagen, &

Van der Vleuten, 2005): 1) the use of problems or cases as stimulus for learning theoretical and factual material; 2) the role of the teacher as a tutor, whose main task is to facilitate learning, rather than distribute knowledge; and 3) the use of small-groups as a stimulus for interaction and discussion.

A popular guideline on how to conduct small-group tutorials is the Maastricht 7-step process, which describes 5 steps for the opening session, independent studying constitutes the 6th step, and the reporting phase (second small group session) forms the 7th step. During the opening session students first clarify unclear terms and basic concepts (step 1), examine the case to identify phenomena to be explained (step 2), brainstorm on the identified phenomena in order to activate previous knowledge (step 3), arrange explanations and formulate tentative theoretical solutions to problems (step 4), and formulate learning objectives for independent study (step 5). In the reporting phase (step 7) students share what they have learned during independent study, review and structure knowledge, and clarify issues that proved to be difficult to understand. At the end of the cycle, self-evaluation takes place, where the learning process, group functioning, and the learning outcomes are discussed.

With the rise of cognitive and constructive educational theories, PBL has been promoted as a way to promote active, explanation-oriented learning, integration of theoretical and practically oriented knowledge, and collaborative knowledge construction practices (Dolmans & Schmidt, 2006; Hmelo, 2004; Norman & Schmidt, 1992). Research indicates that a powerful learning environment intended to foster deep, self-regulated learning and higher-order cognitive skills should include the following elements: 1) the use of complex, challenging and authentic problems, 2) collaborative small group interaction and co-operation, and 3) the encouragement of learners to set goals together with sufficient support (van Merriënboer & Paas, 2003). Problem-based learning would, indeed, seem to have all of these elements built in its educational design (Dolmans et al., 2005; Norman & Schmidt, 1992; Vermunt, 2003).

There is evidence that the aims of the originators of PBL – to create a more humane and meaningful learning environment for students at the premedical stage of studies – have been met reasonably well (Albanese and Mitchell, 2000; Vernon & Blake 1993). Students in problem-based programs have reported high levels of constructivist conceptions of learning (Loyens, Rikers, & Schmidt, 2006). There is, also, some evidence that students in problem-based show higher levels of deep approach (Dolmans, Wolfhagen, & Ginns, 2010; Lycke, Grøttum, & Strømsø, 2006; Newble & Clarke, 1986) than students in more traditional programs. The evidence is, however, equivocal, as some studies have failed to show differences between programs or have even shown higher levels of surface approach in

problem-based programs (Groves, 2005; Nijhuis, Segers, & Gijselaers, 2005; Papinczak, Young, Groves, & Haynes, 2008).

Birgegård and Lindquist (1998) showed that after introducing PBL to a medical program, students felt that their program supported a ”problem-solving way of working, formulation and definition of problems, study of literature other than textbooks, decision-making, and study of literature for solving problems, to a greater degree than a previous cohort. These changes were observed even though students generally reported not especially liking the new problem-based curriculum. Curriculum-level comparisons have been criticized: differentiating among the multitude of possible intervening variables between a method of teaching and students' learning outcomes (Albanese, 2000; Norman & Schmidt, 2000). Process-oriented studies are called for, instead (Dolmans & Schmidt, 2006).

Through reciprocal explanation, elaboration, and generation of learning issues, discussions in the tutorial group are expected to help students deepen their understanding of the issues that are to be learned (Barrett & Moore, 2011; de Grave, Schmidt, & Boshuizen, 2001; Dolmans & Schmidt, 2006; Dolmans & Schmidt, 2010; Schmidt, 1993; Van den Hurk, Dolmans, Wolfhagen, Muijtjens, & Van der Vleuten, 1999; Van den Hurk, Dolmans, Wolfhagen, & Van der Vleuten, 2001; Yew & Schmidt, 2009). Group cohesion and interaction may also contribute to motivation and commitment (Van Berkel & Schmidt, 2000) and motivate students to study independently (Gijselaers & Schmidt, 1990; Moust, 1992; Schmidt, Dolmans, Gijselaers, & Des Marchais, 1995; Van Berkel & Schmidt, 2000). A well designed case linking new scientific content to problems encountered in professional life is expected to strengthen motivation and to instigate an inquiry-like process, where students actively seek to understand meaning, to relate pieces of information to each other, and to solve discrepancies between differing sources in addition to helping students integrate theory and practical application (Norman & Schmidt, 1992; Schmidt & Moust, 2000); essentially, to promote the adoption of central aspects of a deep approach to learning.

The quality of tutorial group functioning has, indeed, been shown to be positively linked with success in examinations (Gijselaers & Schmidt, 1990; Van Berkel & Schmidt, 2000; Van den Hurk et al., 2001). Research on the processes within contexts of problem-based learning is, however, still limited and seems to be taking place at a small number of educational institutions. More research is needed on the associations between what happens in a problem-based small group and learning outcomes (Dolmans & Schmidt, 2006). In the existing research, group functioning has been found to be related to quality of the cases, quality of tutor performance, and the amount of students' prior knowledge (Moust, 1992; Schmidt & Moust, 1995; Schmidt et al., 1995; Van Berkel & Schmidt, 2000). Students' perceptions of the quality of cases have been shown to be strongly as-

sociated with the quality of group functioning (Schmidt et al., 1995; Van Berkel & Schmidt, 2000).

The role of the tutor as a facilitator for learning has also proven to be important (Dolmans et al., 2002; Rothman & Page, 2002). Tutors are needed for stimulating discussion and for making sure that adequate breadth, depth, and applicability of knowledge is reached (Barrett & Moore, 2011; De Grave, Dolmans, & Van der Vleuten, 1998).

There is preliminary evidence indicating that students showing a deep approach to learning find it easier to adjust to a problem-based curriculum (Papinczak, 2009). Lonka, Olkinuora, and Mäkinen (2004) pointed out that the traditional deep approach to learning is, however, individualistic in nature, while modern learning environments often call for a more collaborative way of constructing meaning and understanding. Such a collaborative meaning orientation would be most likely be useful in problem-based learning or in interprofessional team work (Hylin, Lonka, & Pontzer, 2011). Lindblom-Ylänne & Lonka (1999) showed that meaning-oriented and self-regulated medical students in a traditional Finnish medical school did not express a very cooperative attitude. New learning environments may call for redefining what one means by a meaning orientation. In order to deepen our understanding of both context-specific and general aspects of the PBL process, it needs to be further studied, preferably in multiple countries and with differing applications of the general model.

1.6 Overall aims of the research program

In the present research program, the investigators set out to explore and confirm novel dimensions of study orientations, with a focus on the fields of pharmacy and medicine. The results of four studies are set out, then drawn together in the final, General Discussion. Typical of these two fields is that they apply natural sciences, but aim at professional work. We sought, in the course of the program, to develop new versions of self-report instruments order to be able to examine 1) finer distinctions within established constructs (deep and surface approaches to learning) and 2) larger patterns of components of study orientations and epistemological beliefs. With the new instruments, domain- and context-related variation in study orientations and epistemologies was investigated. Furthermore, the development of study orientations was also explored. In order to better understand how collaboration contributes to the quality of learning, students' experiences of the functioning of problem-based small-groups were studied.

Study I was intended to investigate changes in study orientations and epistemological beliefs during a three-year professionally-oriented study program in pharmacy. We also wanted to see whether some earlier findings regarding the relationships between dualism and components of study orientations could be replicated. In addition, we were also interested in the associations between study orientations and study success in that particular group of natural science students.

In order to better distinguish between what students believe to be useful in studying, and the extent they apply their beliefs to practice (according to self report), new measurement scales were developed, translated, and tested in Study II. We were interested in exploring whether measurement could be improved by specifying the context of application for the respondents. The sub-components of approaches to learning and the general structure of the model were examined. Students from two countries were included in order to examine the stability of the model. Differences between domains were investigated: 1) between students from differing domains of study, and 2) between differing educational contexts (i.e., PBL and subject-based medical programs).

In Study III, the focus of the present dissertation was especially on the relationships between approaches to learning, students' epistemological beliefs and their preferences for collaboration. It was of interest how the measures of deep and surface approach would show among a more rich set of variables. We considered how they would be related to new measures of epistemologies and well-being. The variables were expected to form second-order orientations depicting large patterns of connections among variables.

Study IV was designed to investigate how group functioning is related to study success in a problem-based course of microbiology and pharmacology, and how tutor performance and quality of cases for learning are related to group functioning and grades. The importance of collaboration was also addressed here.

2. Overview of the original studies

2.1 Study I

2.1.1 Aims

Study I investigated study orientations in the context of a 3-year, Bachelor-level, program in natural science, preparing students for a career in pharmacy. We wanted to see whether earlier findings showing the link between study orientations and conceptions of knowledge could be replicated. As longitudinal studies of the development of orientations and of conceptions of knowledge had been scarce, we measured them at two points: at the very beginning and at the end of the three-year study program.

The aims of the study were 1) to examine the relationship between study orientations and conceptions of knowledge, 2) to investigate how they change during short, career-aimed studies of natural science, and 3) to explore how study orientations and changes in them are related to study success.

We expected dualism to be associated with a reproducing orientation to learning. We further expected to see some change in study orientations and conceptions of knowledge, with the qualification that the changes might be modest. Study orientations were expected to correlate with study success. The development of study orientations and epistemologies was expected to be different in the groups of above-average and below-average students.

The context of the study

In Finland, the pharmacy program leading to a bachelor of science degree takes three years to complete. The training aims to promote students' acquisition of knowledge and skills for professional work. In the years, that the data for the present study was gathered, the instructional methods at the department can be described as traditional. The vast majority of courses were based on mass lectures and laboratory assignments.

2.1.2 Methods

Participants

Sixty-six students of pharmacy filled in the material at two points in time: at the beginning of their studies and at the very end of the three-year program. Of the final sample 59 were women and 6 men; one participant did not indicate gender. Mean age was 21.9 years, with a standard deviation of 4.2, range 18-45.

At the beginning of studies, a total of 127 participants had filled in the materials, 61 of whom did not participate in the follow-up. Of the 61 dropouts, 23 had left the program during their first study year, and 34 students had continued their studies but did not participate in the follow-up.

Materials

The participants filled in the Task Booklet of Learning (Lonka & Lindblom-Ylänne, 1996), which includes portions of established inventories of study orientations. Eight scales were used in the study. Participants rated statements on a five-point Likert-type scale.

The scales Deep Approach and Surface Approach were adapted from Entwistle and Ramsden (1983). Deep Approach included statements describing an intention to understand meaning, and Surface Approach statements reflecting an aim to learn so as to be able to later reproduce material as it was originally presented.

Five scales were adapted from ILS (Vermunt & van Rijswijk, 1988). Construction of Knowledge is composed of statements reflecting a view of learning as an active, student-led process of creating understanding whereas statements in the scale Intake of Knowledge describe learning as a process of receiving, storing, and reproducing information in a straightforward manner. Three of the five ILS scales measured the regulation of learning. Self-Regulation included statements describing behaviors in which the student takes the responsibility for direction of his or her learning. External Regulation consisted of statements describing studying as guided by the teacher or the learning materials. Lack of Regulation included statements describing confusion about goals and procedures.

The scale dualism was adapted by Ryan (1984) from Perry (1968) and described highly dualistic conceptions of knowledge: a view that true knowledge is certain, absolute, and uncomplicated.

Study success was measured by course grades, obtained from university records. The grades ranged from 1 (“satisfactory”) to 3 (“excellent”) at intervals of 0.25 (for example: 1+; 1,5; 2-; 2). Three variables were computed: (i) a first-

year GPA, computed as the mean of all study units earned during the first year, (ii) the GPA of the last two study years, computed as the mean of all units earned during those final two years, and (iii) a general three-year GPA, computed as the mean of all courses taken during the three years of study.

Procedures

The participants filled in the questionnaire at the very beginning of their studies at a lecture. At the end of their studies, some of the students were given the booklet in a seminar and others received it by post with a prepaid return envelope.

For some of the statistical analyses, the students were divided into two groups based on their three-year GPA score. There were 29 students in the group of students with an above-average GPA and 37 in the group of students with a below-average. Two second-order variables, Meaning Orientation and Reproducing Orientation, were formed out of the original eight scales by computing means across relevant first-order variables, identified with the help of a factor analysis. Meaning Orientation was computed as the mean of deep approach, construction of knowledge, and self-regulation. Reproducing Orientation was computed as the mean of surface approach, intake of knowledge, external regulation, lack of regulation, and dualism.

2.1.3 Results

In order to explore the connections between approaches to learning, regulation of learning, conceptions of learning and knowledge, and study success, correlations among the scales and GPA were calculated. At the beginning of studies, Dualism correlated positively with Surface Approach, Intake of Knowledge, and External Regulation. None of the first year measures correlated significantly with the first-year GPA. At the end of studies, Dualism correlated positively with Surface Approach, Intake of Knowledge, and Lack of Regulation, and negatively with Self-Regulation. The Lack of Regulation after studies correlated negatively with the GPA of the last two study years.

To investigate whether the model of two main study orientations could be applied to the present data, and in order to further explore how dualism relates to these two orientations, a maximum likelihood factor analysis with Varimax rotation was undertaken. In both sets of data, a two-factor solution was chosen, based both on statistical and theoretical grounds. The factors were named '*Reproducing Orientation*' and '*Meaning Orientation*'. Hypothesis 1. was supported: Dualism

loaded positively on reproducing orientation at both times of data collection, showing a relationship between epistemologies and study orientations.

Correlations were calculated between the composite variables Reproducing Orientation and Meaning Orientation, and the three-year GPA. Only the Reproducing Orientation scale measured after three years of study was negatively associated with study success. The positive correlation between the after-studies meaning orientation and the three-year GPA did not reach statistical significance. The first-year orientation scales did not significantly correlate with the three-year GPA. Thus, hypothesis 3., that study orientations are correlated with study success, was supported only in the case of reproducing orientation by the after-studies data.

Scores of the scales associated with reproducing orientation (Intake of Knowledge, External Regulation, Lack of Regulation, and Dualism) diminished during the follow-up period. For the scales in which the change was significant, the value of partial eta squared indicated very small to moderate sizes of effect. Consequently, hypothesis 2. was supported by the scales associated with reproducing orientation: significant changes were observed, but these changes were modest in size.

Reproducing Orientation reported by the students diminished from the first to the second data collection. Reproducing Orientation scores diminished significantly in both groups. The partial eta squared for the overall change in Reproducing Orientation indicated a moderate size of effect. There was no significant overall difference between the Reproducing Orientation scores of the above-average and of the below-average students. However, independent samples t-tests showed that, while the groups did not differ at the beginning of studies, there was a statistically significant difference between them after three years of study; below-average students reported more Reproducing Orientation than above-average students.

Intriguingly, while there was no significant overall change in the students' Reported Meaning Orientation, there was a statistically significant interaction between Meaning Orientation and the level of study success, indicating that Meaning Orientation developed differently for the academically more successful students than it did for the academically less successful students. Below-average students decreased in their Meaning Orientation scores whereas above-average students did not. However, the partial eta squared for the interaction indicated a very small effect size. At the time of the second data collection, above-average students scored higher on meaning orientation than below-average students did.

These findings lend partial support to the hypothesis that study orientations are associated with academic achievement regarding orientations at the end of studies, since there were indications that both reproducing and meaning orien-

tations may be linked with course grades at that time. Hypothesis 4 was partially supported by the data: above-average and below-average students developed differently in terms of their meaning orientation. Neither group, however, showed a significant increase in their level of meaning orientation.

2.1.4 Discussion

The purpose of this study was to examine the relationship between study orientations and conceptions of knowledge in a group of undergraduate pharmacy students. Through a longitudinal approach, we aimed to investigate how these beliefs change during studies at the university. Further, we examined how study orientations and conceptions of knowledge are related to study success.

The results of the present study confirm the robustness of the theoretical model of meaning orientation and reproducing orientation. The results of the factor analyses indicate that meaning orientation and reproducing orientation are applicable even in a population of students participating in professionally oriented undergraduate studies of pharmacy. Students' regulatory problems became a component of the reproducing orientation. Study I thus indicated that the reproducing orientation was linked with problems of the regulation of learning.

The results showed that reproducing orientation and dualistic epistemology were related to each other: Dualistic conceptions of knowledge were linked with a preference for fact-reproducing, externally regulated learning. In particular, dualism was related to surface approach and intake of knowledge, and in the first year, also to external regulation. These empirical results lend support to the theoretical argument that dualistic epistemological beliefs and a mental model of learning that emphasizes the intake and reproduction of knowledge may share common elements and that these concepts may be partially overlapping.

Study orientations were associated with study success only at the end of studies: The above-average students reported more meaning orientation and less surface orientation than did the below-average students. These results indicate that the study orientations students reported at the very beginning of their tertiary studies might not be very strongly, or at all, associated with study success, as measured by course grades. The study orientations students report at the final stages of tertiary education may be more strongly linked with academic success.

Of all the various components of study orientations measured in this study, lack of regulation had the strongest negative association with study success. Based on this study, it seems that being inclined towards external regulation, surface approach and dualism do not necessarily compromise success as measured by course grades, whereas difficulties with regulating one's learning may be more disadvantageous. The traditional, reproduction-oriented nature of the learning

environment may also play a role: Assessment might have been geared towards the reproduction of knowledge.

Study I indicated that reproducing orientation may diminish somewhat even in a rather traditional curriculum. These results differ from those of Zeegers (2001) who found little change in the approaches to learning of science students in a three-year longitudinal study. The present study further indicates that even in the same learning environment, the study orientations of differing sub-groups of students may develop in different directions. Although the difference was small in size, this result may indicate that development was more favorable in the group of high achieving students; they progressed towards a clearer pattern of low reproducing and high meaning orientation.

2.2 Study II

2.2.1 Aims

In Study I we collected data from only the program of pharmacy. Comparisons to students from other academic domains could only be made in relation to earlier published work. In Study II, therefore, we compared medical students' approaches to learning to those of students from other fields. Large samples allowed us to analyze the structure of the instrument with a confirmatory analysis. In Study I we had used established questionnaires which had not made a clear distinction between whether students had a preference for certain practices and whether (according to self report) they applied those practices in actual contexts of learning.

In Study II we created and tested a measurement instrument that was able to distinguish between what students believed to be useful in studying on the one hand, and the self-reported application of their beliefs into practice on the other hand. We chose preparing for an examination as the context of practical application. In Study I the reliabilities of deep and surface approaches to learning had been somewhat disappointing although in line with other similar studies. We were therefore also interested in seeing whether we could obtain higher indices of scale reliability with our new version of the measurement instrument.

In Study II, our measurements were targeted at processes of learning typically associated with deep and surface approaches to learning. Within the surface approach to learning, we proposed and tested a distinction between memorizing and rote learning, while within the deep approach to learning we included understanding subject matter, relating information, and critically evaluating evidence. All aspects were assumed to be related, respectively, to a surface or a deep approach

to learning. As we included different student groups, the stability of the hypothesized model could also be evaluated.

The sample of pharmacy students was enrolled in a rather traditional, subject-based program of applied natural science. In Study II we included a medical school that applied the problem-based learning as a major pedagogical method. We were thus able to compare students' approaches to learning in a problem-based program and a subject-based environment, and thereby investigate the influence of context on students' approaches to learning within one field of applied natural science. Finally, we investigated how the various aspects of approaches to learning were associated with grades in both medical and non-medical student populations.

2.2.2 Methods

Participants

Two groups of students participated in this study. The first, non-medical group students consisted of 865 Finnish students from the University of Helsinki. These students were enrolled at the faculties of arts, agriculture, and law. In this first group, there were 436 first-year students, and 429 advanced (4th and 5th year) students. The second group consisted of 956 Finnish and Swedish medical school students. More specifically, 615 participants from three medical schools in Finland took part in the study; 334 students were enrolled in the 1st and 2nd year of the program and the remaining students in later years. In addition, 341 (female 201) Swedish medical students participated. In this sample, 211 participants were first- and second-year students, while the other students were more advanced. In the Finnish medical sample, students (n = 177) from a medical school applying PBL were compared with students (n = 438) coming from two other Finnish medical schools applying subject-based learning.

Materials

Based on the earlier inventories of approaches to learning, we developed a new questionnaire to measure the perceived importance of approaches to learning on the one hand, and the (self-reported) application of approaches on the other hand. For each statement, it was measured whether students find a learning activity important by using a Likert-scale ranging from 1 (totally disagree) to 6 (totally agree). In addition, for each statement, students needed to indicate "I do this when

studying for an examination" in order to measure the application of a learning approach in context of preparing for examinations.

For surface approaches to learning, we distinguished between memorizing information and rote learning. For deep approaches to learning, we looked at understanding, relating, and critically evaluating information separately. Hence, five composite scales were created to measure the perceived importance of the following: Importance of Memorizing (3 items), Importance of Rote Learning (2 items), Importance of Understanding (2 items), Importance of Relating (2 items), and Importance of Critical Evaluation (3 items). Further, for each of the five importance-focused scales, a corresponding application-focused scale was constructed as depicted in Figure 1. All scales and accompanying items can be found in Appendix A.

Procedure

The questionnaires were mailed to the Finnish non-medical group at the end of the 1999-2000 academic year, together with a cover letter and a post-paid envelope. Four weeks later, a reminder was sent to students who had not returned the questionnaire. Data of the Finnish and Swedish medical students were collected on multiple sites in 2005. The questionnaires were mainly collected during lectures. An attached, informed-consent sheet was signed by all participants.

In the Finnish non-medical sample, students were asked to indicate whether a typical grade for them would be *weak*, *satisfactory*, *good*, or *excellent*. For the students of arts and agriculture Grade Point Averages (GPA) were calculated based on data obtained from university registers. The medical students were asked to indicate whether their typical grade was worse than the average grade of their class, approximately the same as the average of their class, or better than average.

Analyses

Data were analyzed by using a structural-equation modeling approach to test whether the distinction between perceived importance and actual application was legitimate. For the evaluation of the model presented in this study, two groups of fit indices, absolute and incremental, were selected. In the present study, χ^2, accompanied by degrees of freedom, sample size, and p-value, as well as the root mean square error of approximation (RMSEA, Steiger, 1990) were used as absolute fit indices. Maximum likelihood estimations were used for the estimation of the model's parameters.

Two incremental fit indices were included: the Tucker-Lewis index (TLI, Tucker & Lewis, 1973) and the comparative fit index (CFI, Bentler, 1990). Also, the reliability of the two latent constructs (i.e., surface and deep approach) was assessed using coefficient H (Hancock & Mueller, 2001), which captures the degree of replicability of a construct based on its measured indicators. To compare means between students groups studying in different domains (i.e., medical and non-medical) and different learning environments (i.e., PBL versus non-PBL), independent sample t-tests were performed.

2.2.3 Results

Reliability of the Scales

Construct reliability was calculated for all three scales using coefficient H (Hancock & Mueller, 2001). In the non-medical student group, reliability values were .94 for surface approach and .79 for deep approach to learning. For the medical sample, reliability values were .96 and .80 for surface and deep approach, respectively. These values reflect good construct reliability.

Descriptive Statistics

Highest scores were obtained for the importance scale of understanding, whereas lowest scores can be seen for the importance of memorizing. This indicates that all students valued understanding highly. This was also the case, although to a lesser extent, for the importance of relating and critical evaluation in both student groups.

As expected, correlations among the subscales of both the surface and deep approach were positive, significant, and higher compared to the correlations between subscales of the surface with the deep approach. The only exception was the correlation between the importance of rote learning and the importance of understanding in the medical group of students. Also, for each variable, subscales measuring importance and the ones measuring application correlated significantly with each other, indicating a positive relationship between experienced importance and self-reported application. The magnitude of the correlations indicates that the scales tapped onto separate, but related phenomena.

Testing the hypothesized model

Analysis of the hypothesized model with the covariance matrix of the non-medical students (N = 865) resulted in a CFI of .98, a TLI of .96, and a RMSEA of .06. These indices indicate a good fit of the specified model with the data. For the medical students group (N = 956), the analysis showed a CFI of .98, a TLI of .97, and a RMSEA of .05. Again, these indices are indicative of a good fit of the specified model with the data. In sum, it can be concluded that the hypothesized model distinguishing between perceived importance and actual (self reported) application was confirmed in two independent student samples, testing participants in different domains. This implies that the model is stable across domains. All standardized regression loadings of all scales in both students groups were significant, indicating that every importance and application variable significantly contributed to its latent construct.

Domain-specificity of approaches to learning

To test whether students' approaches to learning differ in different study domains, means of both the medical and the non-medical student group were compared with an independent sample t-test. Statistically significant differences were found between the medical and non-medical student group on application of memorization, importance and application of rote learning, importance and application of understanding, importance of relating, and importance and application of critical evaluation. Effect sizes ranged from .11 for the difference in application of memorization (with the non-medical students reporting more frequent use) to .76 for the difference in the importance of critical evaluation in favor of the non-medical students. Notably, the medical students scored significantly higher in rote learning (both importance and application), while in general (with the exception of the application of understanding and the non-significant difference on the application of relating), the non-medical students scored higher in the subscales of the deep approach to learning. These results demonstrate that students' approaches to learning do differ depending on the domain one is studying in.

Context-specificity of approaches to learning

Significant differences between students in a medical school applying PBL and students from two subject-based, non-PBL medical schools could be observed for both the importance and application of memorization and understanding, with

the PBL-group obtaining higher scores. This pattern indicates that PBL students valued memorization as a learning strategy higher and reported more frequent use of it in preparing for examinations compared to non-PBL. Neither of the student groups valued memorization highly, nor did they use it frequently. Notably, although PBL students obtained higher scores on surface approach (i.e., memorization), they also valued studying for meaning higher and the use of study strategies aimed at understanding subject matter more often than the non-PBL group. In other words, they scored significantly higher on deep approach. Cohen's *d* measure of effect size, however, indicated that the differences found were very small in magnitude.

Relationships between approaches to learning and grades

In the non-medical sample, all the six deep approach-related scales correlated positively with both the self-reported typical grade and actual GPA in the non-medical sample. The self-reported typical grade and the actual GPA correlated strongly with each other. In the medical sample, the scale application of understanding had the highest correlation with self-reported grade level. Interestingly, in the medical sample, application of rote learning was nearly as strongly correlated with grade level as (self-reported) application of understanding.

2.2.4 Discussion

In Study I we looked at the development of students' rather general preferences for meaning and reproducing oriented learning and found that, even in a traditional program of applied natural science, reproducing orientation may diminish somewhat. Study II aimed at creating and testing a measurement instrument that would be able to distinguish between what students believe to be useful in studying on the one hand, and the (self-reported) application of their beliefs into practice on the other hand. In addition, the study domain and the wider context in which students are studying were taken into account by including participants from different programs (i.e., medical and non-medical students, and PBL versus non-PBL students). Results indicated that measurements of approaches to learning targeted at importance and application tap onto differing, yet related aspects of student approaches to learning. Students' reports on what is useful for good quality learning and their study practices appeared separate, but related constructs. All regression weights further indicated that all importance and application variables significantly contributed to their latent constructs (i.e., surface

and deep approach), suggesting that not only the distinction between importance and application is valuable, but also the subdivisions of the surface approach into memorizing and rote learning, and of the deep approach into understanding, relating, and critical evaluation, are valid.

As mentioned, the indicators of the surface and deep approach also, generally, seemed legitimate, as reflected in the good model fit. This finding lends further support to the view that approaches to learning are multidimensional (Kember, Biggs, & Leung, 2004). A somewhat similar two-factor solution was recently observed in another Finnish study (Parpala, 2010) using a modified version of the Experiences of Teaching and Learning Questionnaire (Entwistle et al., 2003). Furthermore, our hypothesized model seemed stable across different domains, since in both student samples, good model fits with the data were obtained. Compared to Study I, Study II represents a more rigorous attempt to empirically investigate the theoretical structure of the measurement instrument.

The reliabilities in deep and surface approaches to learning had earlier been rather low, as is often the case, particularly for the surface approach to learning. However, the construct reliabilities (i.e., coefficient H) of the scales created in this study proved to be very good. Both latent variables showed reliabilities well above those commonly observed with deep and surface approaches to learning (for a review, see Watkins, 2001).

The results further indicate that university students appear to realize that the importance of surface approach to one's learning process is smaller than that of a deep approach. Students responded positively to items measuring the importance of a deep approach to learning (i.e., understanding, relating, and critical evaluation), but simultaneously gave considerably lower ratings to scales measuring their application in the context of preparing for examinations. For a surface approach to learning, on the contrary, values for application were somewhat higher than those for importance. These findings reflect a discrepancy between beliefs and (self reported) activities, and stress the importance of the distinction of these aspects in educational research. On the other hand, the finding may also indicate that the demands of assessment are not aligned with the demands of course work (Biggs, 1996).

Domain-specificity of approaches to learning

Considerable differences on almost all subscales emerged when students in different domains were compared, indicating that approaches to learning are domain-specific. The results lend support to the conclusions of Study I, where we had compared the observed scores to those reported in earlier studies with students

from other academic fields and found students of pharmacy to score high on reproducing orientation, even more so than medical students (Nieminen, Lindblom-Ylänne, & Lonka, 2001). The finding in Study II that medical students gave lower ratings to critical evaluation of knowledge than to understanding, may also reflect the nature of medical studies, which offer relatively limited opportunities for the critical examination of research paradigms, methodological choices, and relationships between evidence and conclusions; this pattern is in contrast with that for the arts and humanities, where critical evaluation and the analysis of ill-defined problems take centre stage from the very beginning of studies (Jehng et al., 1993; Muis, Bendixen, & Haerle, 2006). It should be noted, however, that the differences between medical and non-medical students were small on several subscales (scales measuring application of understanding, application of relating, and both of the two scales measuring memorization). The entrance examinations for Finnish medical schools are rigorous, and the students entering the programs can be expected to be rather well equipped with learning skills. Very large differences might actually be more surprising than the relatively small ones observed in the present study.

Context-specificity of approaches to learning

In Study I the context was a professionally-oriented 3-year traditional curriculum in pharmacy. In Study II, we were able to compare medical students from two differing programs. Means were higher for a deep approach to learning than for a surface approach in both the PBL, and the non-PBL group. PBL students scored higher on both memorization as well as deep understanding. We were not able, however, to replicate the findings of Lycke (Lycke et al., 2006) and Newble (1986), as the differences between contexts of learning found in Study II were small, possibly indicating that assessment criteria may be a greater determinant for the learning approach one adopts than the instructional approach. In Study II we contextualized the application of approaches to learning in terms of preparing for examinations. The results might have been different, had we, instead, asked students how much they apply the practices in question to the context of preparing for small group sessions. The qualitative differences in application of problem-based learning might be worth investigating when examining the effects of differing contexts to the ways in which students go about learning.

Relationships between approaches to learning and grades

In the non-medical sample the pattern of associations between approaches to learning and study success resembled earlier results: All the scales measuring aspects of deep approach were positively, but not very strongly, linked to grades. Among medical students, both the application of rote learning and application of understanding in preparing for examination showed a small correlation with grades. This result is somewhat contradictory to the result found in Study I, in which the reproducing orientation at the end of three years of study was negatively associated with grades; only general predispositions were measured in Study I.

Conclusion

Study II showed that what students' believed to be important in university studies and what they did (as in self-report) when preparing for examinations differed from each other when measured simultaneously. Furthermore, memorizing and rote learning, and understanding, relating, and critical evaluation of knowledge appear to be different, although related, aspects of a surface and a deep approach to learning. For both theoretical clarity and practical applicability, it may prove worthwhile to seek to empirically measure such fine conceptual and contextual distinctions within students' approaches to learning.

2.3. Study III

2.3.1 Aims

In Study II, deep and surface approaches to learning were examined at a fairly detailed level; the effort was to separate what students believed about certain practices associated with the approaches from how much (according to self report) they applied them to the context of preparing for examinations. The measurement had explored distinctions among beliefs and practices focusing on processes of rather individual nature. Lonka et al. (2004) have noted that deep and surface approaches to learning as traditionally conceptualized and measured, are rather individualistic. They argued that in learning environments where the collaborative nature of knowledge building is taken seriously and co-operation is used, a more collaborative version of a deep approach would be useful.

Study III was intended to explore the construction of a research instrument that would measure such a combination of preferences. In addition to approaches

to learning and conceptions of learning and knowledge, regulative strategies, and experiences of stress, anxiety, and disinterest were also included in order to build a comprehensive picture of medical students' orientations to learning and studying in medicine. We compiled an instrument, called MED NORD (Medical Education in Nordic Countries), which is a collection of measurements that have previously shown good predictive value, validity, and reliability.

Context of the study

According to the Swedish Chancellors Office, the mean age of students entering medical schools in Sweden was 22 years in 2006. All Swedish medical students participate in a five-and-a-half-year medical program combining preclinical and clinical studies. These medical schools represented the rather traditional model of medical education, which is subject-based with a clear division between preclinical and clinical phases.

2.3.2 Methods

Participants

The participants in the first data collection with the questionnaire were 146 first (n=109) and fourth year (n=64) medical students at two major Swedish universities. The second data collection was from 134 students in one Swedish medical school. Among the responders, 70 students were first-year students (mean age 23) and 64, fourth-year students (mean age 24).

Construction of the instrument

The pool of items was constructed based on our previous research on questionnaires and new interviews with our students. The first version of our questionnaire was the result of modifying relevant parts of existing questionnaires and creating some new items. Various instruments were already available, having been previously developed and validated in different European countries and languages. MED NORD was designed to measure approaches to learning (Entwistle & Ramsden, 1983; Lonka & Lindblom-Ylänne, 1996), conceptions of learning and knowledge (Lonka et al., 2001), problems in self-regulation (Vermunt & van Rijswijk, 1988), cognitive and attributional strategies (Nurmi, Salmela-Aro, &

Haavisto, 1995), stress (Dahlin et al., 2005; Elo, Leppänen, & Jahkola, 2003), anxiety and disinterest (Mäkinen, Olkinuora, & Lonka, 2004). The items were translated and culturally adapted.

The questionnaire

This version of MED NORD consisted of 93 questions. The questionnaire took approximately 20 minutes to complete. Only the items and scales that remained unchanged through both data collections are reported here.

Well-being was measured by 13 items measuring Stress, Exhaustion (Maslach & Jackson, 1981), Lack of Regulation (Vermunt & van Rijswijk, 1988) as well as Anxiety and Lack of Interest (from Inventory of General Study Orientations, IGSO, Mäkinen et al., 2004).

Students' cognitive and attributional strategies were measured by the Strategy and Attribution Questionnaire (SAQ, Nurmi et al., 1995), comprising 12 items that formed the scales Optimism, Task Avoidance, and Social Optimism.

Students' beliefs about the nature of learning and knowledge were measured by Conceptions of Learning and Knowledge Questionnaire (CLKQ) developed by the Progressive Inquiry Research Group at the University of Helsinki (Lonka et al., 2001). After several analyses, 26 items remained, forming the scales Certainty of Knowledge, Innate Ability, Practical Value, Reflective Learning, Valuing Metacognition, Strategic Planning, and Collaboration.

In addition, 12 items measured deep and surface approaches to learning. These items were the same as those used in Study II to measure the perceived importance of practices associated with deep and surface approaches to learning.

Perception of the learning environment, based on 12 items, was measured by the scales Problem solving, Focus on exam & details, and Scientific perspective. These dimensions measured how students perceived the medical school as encouraging these three aspects of learning (Birgegård & Lindquist, 1998). Other aspects were measured by 18 items that formed the scales Disengagement, Receiving Feedback, Workload, Worry, and Satisfaction (Dahlin et al., 2005).

Socio-demographic background, with 13 questions, covered information about students' age, sex, ethnicity, and civil status. Students were also asked about their typical grades (below average, average, above average or do not know).

Procedure

The first data collection took place in the spring of 2004. The study was carried out with medical students at two major Swedish medical schools. After this, some items were omitted, modified, replaced or added. The second data collection took place in the spring of 2005 at one major Swedish medical school.

2.3.3 Results

The Internal consistency of the scales was satisfactory or good, ranging from .058 to 0.87. The only Alpha below 0.60 was for Surface Approach, deep approach reaching an Alpha of 0.63. Both of the reliabilities for approaches to learning are – although commonly observed in research in the SAL tradition – somewhat disappointing and can be described as satisfactory at best.

A principal component analysis (PCA) with Varimax-rotation was performed in order to determine how the scales related to each other. The results showed five factors, which were named as follows:

Dysfunctional Orientation. Various dysfunctional aspects of studying loaded strongly on the first factor, namely: Exhaustion, Anxiety, Lack of regulation, and Stress. Task avoidance had a small loading on this factor. All of these aspects correlated negatively with Optimism.

Collaborative Knowledge Building Orientation. Deep approach loaded strongly on this factor. Collaboration, Reflective learning, and Valuing Metacognition loaded moderately.

Cookbook Orientation. Certain knowledge, Surface learning, and Practical Value had high loadings on this factor, whereas Strategic Planning loaded moderately.

Social Orientation. Typical of this factor were high loadings on Social Optimism and Lack of interest.

Individual Abilities Orientation. The variable Innate Ability dominated this factor. Task avoidance and Valuing Metacognition had small positive loadings, whereas Collaboration and Strategic Planning loaded negatively.

2.3.4 Discussion

In Study III, Dysfunctional orientation was a combination of various problematic symptoms and attitudes, such as exhaustion, anxiety and stress. These emotional problems were related to problems in regulating one's own learning and avoiding tasks, as well as being very optimistic. Correlations of Dysfunctional orienta-

tion with other variables showed that this orientation negatively correlated with reported grades and also colored students' perceptions of their learning environment negatively. These results are in line with those of Heikkilä et. al. (Heikkilä & Lonka, 2006; Heikkilä et al., 2011), who studied Finnish university students from a variety of domains.

From the point of view of deep approach to learning, new relations were discovered. Collaborative knowledge building orientation appeared to involve the intention to construct a holistic picture of materials to be learned, to reflect on this knowledge, and to collaboratively reformulate new knowledge. In this context, metacognitive processing was seen as a collaborative, rather than an individual effort.

The surface approach also emerged in a new way. Cookbook orientation pointed toward an orientation where students would not be happy with vague theoretical explanations, but instead would like to have certain, concrete, and practical advice. They might prefer a teaching strategy that would provide them with a ready-made collection of instructions, "a cookbook'. Younger students would be more likely to express this kind of view, which is well in line with previous research (Lonka & Lindblom-Ylänne, 1996). Cookbook orientation appears different from both 'professional orientation' (Lonka & Lindblom-Ylänne, 1996) and worklife orientation (Mäkinen et al., 2004) because it includes a strong belief in certain knowledge as well as a surface approach to learning.

The final two orientations appear the least informative and somewhat difficult to interpret. Social orientation was a combination of social optimism and lack of interest. Social orientation was introduced already by Entwistle and Ramsden (1983). They showed it to be related to unstable or weak study progress. In the present context, social orientation also correlated negatively with satisfaction. It is difficult to say to what extent the orientation found in the present study would represent a similar phenomenon as Entwistle and Ramsden's social orientation. Individual abilities orientation was strongly dominated by only one variable, Innate Ability. We interpreted this factor as reflecting a solitary attitude to learning, where processing takes place within the individual's mind only.

Methodological reflections

We developed our instrument by combining parts of several instruments that had been demonstrated to be valid and reliable in previous studies. Our items and subscales were translated and culturally cross-validated in order to capture some critical elements of studying that were expected to either enhance or thwart Swedish medical students' effective and enjoyable learning.

Only one Cronbach's Alpha in our study was below the conventional psychometric limit of poor scale coherence. This scale was surface approach, which is a central focus of the present study. As found out in Study II, the new ways of measuring both surface and deep approaches to learning appeared more reliable.

Conclusions

In relation to surface and deep approach to learning, the central findings of Study III were the two new orientations to learning: Constructivist Collaborative view and Cook book approach. These were intriguing, since they were connected with two major findings: First, a deep approach was related to preferring collaborative activities, reflective learning, and metacognition. Second, in the context of medicine, a surface approach was related to a preference for directly applicable and certain knowledge. New patterns of approaches to learning and epistemologies thus emerged. In the following study, the role of collaboration in problem-based learning in medicine will be looked at more closely.

2.4 Study IV

2.4.1 Aims

The present research program reported in the dissertation was intended to investigate students' approaches to learning and study orientations in medicine and pharmacy. Study III explored the connections between a deep approach to learning, reflective learning, and a preference for collaborative knowledge building. It was argued that such a combination of preferences might be useful in the kind of collaborative learning environments that seek to promote the development of learners towards active, self-regulating, and deep learners.

In Study II, it was also found that, while there were differences between one medical school applying problem-based learning and the two other Finnish medical schools, the differences were rather small in magnitude. The meaningfulness of comparing educational methods at the level of whole curricula has, in fact, been a somewhat controversial issue in the literature on medical education (Albanese, 2000; Colliver, 2000; Norman & Schmidt, 2000). It has been argued that investigations of the processes involved in problem-based learning might, instead, help one understand how, and under what conditions, methods like PBL

are able to support high quality learning and the development of students as learners (Dolmans & Schmidt, 2006).

PBL has been implemented differently across a variety of educational settings, yet studies of PBL processes have been conducted in a limited number of medical schools. Study IV was intended to investigate how aspects of PBL group functioning are related to each other and to success in a written course test in a recently established, hybrid PBL curriculum.

The aims of the study were to investigate the relationships between tutor performance, case quality, and group functioning, and to examine the relationship between study success and the quality of PBL small-group learning. Study IV thus represented an effort to look into a central context of medical education, in which students are expected to learn medical science but also to develop useful, expert-like skills of knowledge acquisition and academic inquiry.

The context of the study

In 1998 the Faculty of Medicine at the University of Helsinki transformed its program into a new PBL curriculum, which resembled the hybrid model at Harvard Medical School. At that time, some tutors had had a few years of experience with the method, while others had taken only one course on PBL and tutoring (Vanhanen, Pitkälä, Puolakkainen, Strandberg, & Lonka, 2001). The participants of the present study were the fourth cohort in this curriculum. Thus, the program could be characterized as fairly new at the time of data collection.

Two PBL tutorials were scheduled for each week along with some lectures, group work, clinical sessions and/or laboratory exercises. The topics of the courses were integrated across several, but not all, subject boundaries, combining, for example, anatomy, physiology and pharmacology. Most courses were focused mainly on 2 or 3 of these domains. Students of medicine and dentistry studied together in mixed PBL groups during the pre-clinical phase (the first 2 years). Vertical integration between preclinical and clinical phases was limited.

Data were collected at the beginning of the first term during a 5-week course on microbiology and pharmacology, following immediately after a 2-week introduction to PBL. The course consisted of 8 tutorials organized around 7 cases, 12 lectures, 4 expert lectures and independent study time. During most weeks there were two 90-minute PBL sessions, each comprising both a reporting phase, which finished the previous case, and an opening phase, which started the next case.

At the end of the course, students took a course test. During the rest of the year, there were 3 opportunities (2, 3 and 5 months after the original course test) to retake the test, for students who had not passed or had not been present at the

first opportunity. Students had to succeed in all summative course tests of the pre-clinical phase before moving on to the third year.

2.4.2 Methods

Participants

The participants (n =116) were first-year medical and dental students at the Faculty of Medicine, University of Helsinki, in 2001. The total number of first-year PBL groups was 14. There were 8–11 students in each group. We were unable to gather data from 2 small groups, our final sample being 12 groups (comprising 120 students, 83% of the total of 141 first-year students). The participants were given the option to reply anonymously; only the group to which they belonged was indicated. Four students were either not present at the time of data collection, or did not return the questionnaire. The mean age of the entire cohort of students from which our sample is taken is 21 years, gender distribution being 71% women and 29% men.

Materials

The participants completed a questionnaire on student perceptions of PBL (Lonka, Sauri, & Paganus, 2001) at the end of a PBL session. The questionnaire contained 23 statements presented in Finnish. Students rated them on a scale ranging from 1 to 4 or, alternatively, indicated that they were unable to give a rating. Based on the grammatical structure of the sentences, these items were grouped into 3 sections, for which the description of points on the scale differed slightly. For the first group the descriptions ran from "I disagree completely" to "I agree completely", for the second group from "poor" to "excellent", and for the third group from "poorly" to "excellently".

Tutor performance (computed as the mean of 4 items) measured how competent students thought the tutor was, focusing particularly on his or her role as the facilitator of group discussion. *Case quality* (3 items) probed into how well students felt the case to promote learning. *Group functioning* (4 items) measured the overall quality of group functioning.

We also presented one statement about students' own personal contribution, which was not incorporated into any of the other scales. This statement (hereafter called *Own contribution*) read: "I found my own contribution today (participants1 selected either poor, satisfactory, good, or excellent)".

In addition, the participants were asked to estimate the time that they had spent studying for that particular case. An overall self-study variable was calculated as the sum of time spent on independent study. The total study time was expressed in minutes.

The grade scores of a 3-hour, summative course examination were used as a measure of study success. The examination was constructed and scored independently of the research project by the teachers of the Department of Biomedicine. It consisted of 16 short questions, 4 true–false questions and 4 definitions of medical terms. The maximum score was 24 points, graded in increments of 0.25 points (for example, it was possible to receive a total of 14.75 points on the examination). The pass mark was 12 points.

Procedures

Each tutorial group was visited once by a researcher, who explained the purpose of the study, administered the questionnaires and collected them at the end of the session. Thus we have questionnaire data associated with 1 case from each group. The case, however, was not the same for every group.

As individual questionnaires could be linked only to the group to which the participant belonged and not to the identity of the individual student, analyses of the relationship between study success and quality of PBL were conducted at the group level. For this purpose, group-level mean variables were calculated for examination scores and questionnaire scales. Two test score variables were calculated: the results of the course examination immediately following the course, and answer final test score corrected with the results of the retakes.

2.4.3 Results

In order to investigate the internal consistency of the scales, Cronbach's alphas were calculated. Reliability coefficients were high for the scales *Tutor performance* (α=0.77) and *Group functioning* (α=0.82), and somewhat low for *Case quality* (α=0.57). Means and standard deviations indicate that students were satisfied with their cases, groups and tutors. The students, however, evaluated their own contribution as modest.

Spearman's rho correlation coefficients were computed to investigate relationships among the variables measured in the inventory and examination scores. *Case quality*, *Group functioning* and students' *Own contribution* all correlated with each other. Interestingly, there was only a low correlation between tutor

performance and group functioning. Time spent on self-study did not correlate with any of the other variables.

Fourteen students needed to retake the examination. Two students participated only at the second opportunity. After the first year, only 3 students had not passed the examination. The average performance of the groups ranged between 59% and 70% before retakes. The pass mark was 50%. There was great variation in terms of study time invested.

Student grades in the first examination correlated strongly with *Group functioning* (rho=0.70, $p<0.05$) and *Case quality* (rho=0.58, $p<0.05$). Tutor performance was non-significant in relation to examination scores. There were no significant correlations between the scales and the final examination scores after retakes, and nor did the students' own contribution or self-study time correlate with examination scores.

2.4.4 Discussion

The results of the present study show a strong relationship between group functioning and course grades. These results are in line with those of van den Hurk et al. (2001), who also analyzed data at the group-level and found a strong link between the depth of discussion and course grades. The results support the claim presented in Study III about the importance of collaboration in regard to high-quality learning.

Further, the data showed strong associations between case quality and both group functioning and study success (Gijselaers & Schmidt, 1990; Schmidt et al., 1995; Van Berkel & Schmidt, 2000). An earlier qualitative study in Helsinki (Paganus, Lonka, & Hätönen, 2001b) indicated that cases had an effect on tutor behavior and also on group functioning. The results of the present study do not, however, necessarily imply a unidirectional causal relationship between cases and group functioning or between case quality and study success. The methodology was insufficient to ground causal inferences.

The present data are correlative in nature and do not allow for detailed analyses of processes underlying associations between aspects of PBL and study success. Given these limitations of the study it is, however, interesting that results of the previous Dutch studies were supported, from the results obtained with our sample of first-year students from a recently established hybrid PBL curriculum. A limited number of studies has previously investigated aspects of group work in relation to achievement in summative course examinations.

The association found between tutor performance and group functioning was weaker than those found in earlier questionnaire studies (Schmidt & Moust, 2000;

Van Berkel & Schmidt, 2000). It may be that the participants failed to see the benefits of indirect guidance that may be equally effective. On the other hand, in PBL students may focus more on group functioning than on teacher's activities, as group discussions take such a central role in the PBL process.

Van Berkel and Schmidt (2000) proposed that group attendance might reflect commitment to studying, which in turn would be a strong determinant of learning. We measured students' perceptions of their own contribution, which were associated with perceptions of group functioning and of case quality; these did not correlate with the group's study success. It is difficult to read causality into this pattern of correlations. Perhaps readiness to contribute during small group sessions does not directly reflect personal commitment to studying or the quality of learning.

The commitment variable is, however, worth examining: The relationships between collaborative activity, individual contribution and self-study are theoretically very important in PBL research (Paganus, Lonka, & Hätönen, 2001b). Students' initial commitment may affect the functioning of the group (Paganus, Lonka, & Hätönen, 2001a). In the future, it would be useful to obtain measures of commitment to studying before and during the course itself. Such longitudinal data would allow for more detailed analyses of the interactions between these factors.

The fact that self-study time did not correlate with any other measures is somewhat surprising. The relationship between self-study and study success is complex, however, involving several interrelated factors (Van Berkel & Schmidt, 2000; Van den Hurk, Wolfhagen, Dolmans, & Van der Vleuten, 1998; Van den Hurk, Wolfhagen, & Van der Vleuten, 1999). Students may, for instance, need to increase self-study time to compensate for low small-group attendance or insufficient prior knowledge (Van Berkel & Schmidt, 2000).

For privacy concerns, participants were allowed to answer anonymously. Consequently, we do not know the exact demographics of our sample. Yet, as students in our sample represent a large portion (83%) of all first-year students, and as almost all students from the 12 studied groups participated in the study, our group of participants can be expected to well represent the entire class. Furthermore, the pre-condition of participant anonymity, as implemented in the present case, limited the analyses of study success to the group level and reduces the number to 12. In the future it would be useful to collect comparable data with individually identified participants. Such a design would allow for multilevel analyses of the interplay of individual and group-level factors.

The validity and reliability of the new group functioning scale should be examined further. In the present study, the short scale showed high internal consistency and strong associations with both case quality and study success. Such a brief instrument can be useful when time is a limiting factor, for example, in longitudinal designs where data collection is repeated frequently.

3. General discussion

The present dissertation explored dimensions of study orientations and contexts of learning with a particular focus on pharmacy and medicine. In order to investigate novel dimensions of, and finer distinctions within study orientations, versions of self-report instruments were developed and tested, using samples from several domains of study, varied contexts of studying, and from two Nordic countries. The linkages between study orientations and students' epistemological development were explored and confirmed. The relationships between study orientations and study success were investigated. The context of problem-based learning was studied in order to find out how collaboration contributes to the quality of learning.

3.1 Orientations and epistemologies

The results lend support to the view that epistemological beliefs, conceptions of knowledge, and approaches to learning are interrelated. In Study I, Dualism was associated with a Surface Approach to Learning, with an Intake of Knowledge mental model of learning, and with External Regulation, forming a second-order factor called Reproducing Orientation. Although epistemological beliefs were not measured in Study II, it is worth noticing that Critical Evaluation of Knowledge, which was measured, is theoretically very close to epistemologies as defined by Hofer and Pintrich (1997). Recently, Phan (2008) has both theoretically argued, and empirically confirmed that critical reflective thinking, epistemological beliefs, and approaches to learning are associated with each other. The results of Study III support this view: Reflective Learning and Deep Approach to Learning both loaded onto the orientation of Collaborative Knowledge Building, whereas the scale Certain Knowledge was a constituent of the same orientation as a Surface Approach to learning. Thus, the present results suggest that a dualistic view of knowledge is related to a reproducing orientation to learning and that more sophisticated epistemological beliefs are linked with reflective, meaning-oriented learning; much the same way in medicine and pharmacy as in other fields.

The present finding that medical students reported lower levels of critical evaluation of knowledge than students in other fields does, however, lend support to the theoretical view that students of natural sciences, dealing with well-defined problems more often than students in humanities and social sciences, tend to hold somewhat more dualistic views of knowledge (Jehng et al., 1993; Lonka et al., 1996; Zeegers, 2001).

It should, however, be kept in mind that self-selection of students into differing domains, which was not investigated in the present study, may also play a significant part in producing the observed domain-related differences in epistemologies. Trautwein and Lüdtke (2007; 2008) showed that students choose fields that correspond to their existing epistemological beliefs. However, their results also showed that those differences became slightly more pronounced during the early years of the higher education experience. Some studies reported that in sciences, believing in the certainty of knowledge may be strengthened in the early stages of studies, as students study issues on which there exists a wide scientific consensus; and that this effect may be somewhat reversed as students become involved with the practices of scientific inquiry and become familiar with issues on which there does not exist a strong agreement (Jehng et al., 1993; McCune & Hounsell, 2005). Jehng et al. (1993) argued that in natural sciences such issues are mainly dealt with at later stages of expertise, as tentative scientific theories and the actual construction of scientifically new knowledge are increasingly confronted. In a study by Lonka and Lindblom-Ylänne (1996) the novice medical students reported the highest levels of dualistic ideas.

3.2 Dimensions and contextual variation

Measuring practices associated with approaches to learning at the level of perceived importance and, simultaneously, as contextualized in terms of preparing for examinations proved to be fruitful. First of all, the scales measuring application were associated with measures of study success somewhat more strongly than the scales measuring importance. Furthermore, as measurement was contextualized in terms of preparing for examinations, students did not report the extremely high levels of deep approach that they did when asked about importance. A contextualized way of measuring variables may be helpful in reducing the ceiling effect sometimes observed in research on SAL, for example in the case of the mental model 'construction of knowledge' (Vermunt, 1998).

Study II also showed that combining both the importance and application scales produced much higher reliabilities than those observed in Study III, where only the importance-related items were employed. Low reliabilities have been common in previous inventories of student learning (Watkins, 2001). This has usually been attributed to the fact that the constructs themselves are heterogeneous (Biggs, 1993; Richardson, 1990; Watkins, 2001) resulting in lower reliabilities than in studies where narrow concepts are investigated. In Study II students actually rated all of the approach-related practices twice: first from a more general

perspective and immediately afterwards from a more narrowly defined, contextualized point of view. Such a way of measuring approaches to learning enables the measurement of the multidimensional constructs in such a way that several aspects can be covered; each is probed more than once, without having to resort to contrived versions of the same statements as an effort to improve reliability. Such an approach might be worth examining and testing further.

Separating the subcomponents of memorizing, rote learning, understanding, relating, and critical evaluation of knowledge made it possible to analyze finer distinctions within the multifactorial second-order constructs of deep and surface approaches to learning. In particular, examining critical evaluation of knowledge separately from understanding and relating provided information about the nature of a deep approach to learning in medicine. The fact that the structural model fitted samples of both medical and non-medical students, including students from two countries, lends support to the expected underlying structure of the instrument.

3.3 Domains of study

Students in applied natural sciences have often reported lower levels of deep approach (or meaning orientation), and higher levels of surface approach or (reproducing orientation) than students in other domains (Nelson Laird et al., 2008). In line with such earlier results, the present study found that medical students scored lower than students from other fields in some aspects of deep approach, particularly in critical evaluation of knowledge and in the importance they placed on relating ideas and on aiming for understanding. Medical students did not, however, report lower levels of aiming for understanding or of relating ideas in the applied context of preparing for examinations. They did report somewhat higher levels of rote learning than non-medical students, but not higher levels of memorizing than students from other fields. We only had a comparison group in Study II, but comparing the results of Study I to earlier published studies, students of pharmacy appeared to be rather strongly reproduction oriented, also as compared to medical students – even though both are professionally oriented programs of natural science. This may partially be due to the fact that medical student population also included more advanced students whereas the pharmacy program only lasted three years. In sum, regarding differences between students from differing domains, the results of the present dissertation are generally in line with earlier studies.

As these results are based on self-report instruments only, we do not have further information on whether medical students evaluate questionnaire items

the same way as students from other fields. Whether "aiming for understanding" really means the same for them as it does to students of humanities, for example, remains a question for future research.

3.4 Study success

The findings of the present studies generally confirm that approaches to learning are associated with study success, even as measured by course grades (Watkins, 2001). Also in line with earlier studies, the associations were rather small in magnitude. For the group of non-medical students, the results of Study II were rather straightforward: a deep approach to learning was systematically linked with study success; the scales measuring application showed slightly higher correlations with grades than the scales measuring importance. In the medical student dataset, the link between approaches to learning and study success was not quite as straightforward, and the correlations were, overall, lower than in the non-medical sample.

For students of pharmacy, the results of Study I showed that the level of reproducing orientation at the end of the three-year program was negatively related to grades, but the level of meaning orientation was not. There was a small interaction between level of study success and the development of meaning orientation over the three-year period. In Study III, the two orientations that included deep and surface approaches to learning failed to correlate with self-reported grades. In that sample of medical students, Dysfunctional Orientation, which included lack of regulation as one of its components, correlated negatively with study success. This result is in line with the findings of Study I, in which the scale Lack of Regulation had the strongest negative association with grades.

As a whole, the results of the four sub studies seem to indicate that at least in medicine and pharmacy, which are both professionally oriented programs of natural science, being inclined towards a surface approach to learning does not necessarily compromise success as measured by course grades, whereas difficulties with regulating one's learning may be disadvantageous. It is likely that the kind of confusion about how to study that the scale Lack of Regulation measures, is indicative of the kinds of problems that typically lead to poor performance. An externally regulated, surface-approach leaning student may be able to get through basic training in applied natural sciences with a systematic – if somewhat superficial – orientation to studying.

In fields such as pharmacy and medicine, even when deep understanding and a critical evaluation of the premises of knowledge are sought, a professional will need to be able to recall, understand, and apply a large amount of exact detailed

information, such as names of anatomical structures and chemical substances, types of symptoms, diagnostic categories and criteria, procedures of examination and operation. While understanding of causes and effects of organic and inorganic processes, relationships of parts to a whole, and linking terms with their meaningful contexts of application are likely to aid memorization (Woods, 2007); there are, at the end of the day, large numbers of particulars to be remembered. Committing all required material to memory may call for some repetitive rehearsing and reviewing even when the issues at hand are well understood by the student. These features of studying in professionally oriented programs of natural sciences may, partially at least, be reflected in students' self-reported approaches and orientations. The combination of aiming to understand and an emphasis on rote learning observed in Study II is reminiscent of the "Chinese paradox" where students – particularly in China – have reported seemingly successful efforts to gain deep understanding through (or perhaps combined with) rote memorization (Kember, Wong, & Leung, 1999; Kember, 2000).

It is noted that the results of Study I further suggest that even in the very same environment, differing students may develop in various ways. This finding is reminiscent of the small portion of medical students, identified by Lindblom-Ylänne and Lonka (1999), who were able to maintain a meaning orientation to studying even in a curriculum that was experienced as encouraging a superficial, reproduction oriented way of studying.

In Study II, contextualizing the measurement of approaches to learning in terms of preparing for examinations may have primed students to keep the demands of assessment in mind when responding to statements. There is evidence that the multiple choice format of assessment is likely to evoke the inference that a surface approach is needed in order to study successfully (Scouller, 1998), and that some students are more vulnerable to such an interpretation than others. Lindblom-Ylänne and Lonka (1999; 2001) found that only a small portion of students was able to resist the perceived demand to study superficially.

Finally, it should be kept in mind that in the present study, the mean values for a deep approach were very high even for medical students. The general level of education in Finland is known to be very high (Sahlberg, 2007) and even students expressing a preference for a surface approach are likely to have relatively good learning skills. Deep approaches were very high in Studies I – III. Extreme cases of repetitive rote learning may be rare in the cohorts of students that make it to Finnish universities. In future studies it might be useful to examine these issues further, and to analyze subgroups of students who might show exceptionally high levels of externally-regulated learning and surface approach. Such an investigation might reveal at what levels a surface approach to learning becomes harmful in fields like medicine and pharmacy. Person-oriented measurements, such as

cluster analyses, might be useful to identify different subgroups of students (e.g., Lindblom-Ylänne & Lonka, 1999; 2001; Heikkilä et al., 2011).

3.5 Collaboration, deep approach, and problem-based learning

A preference for collaborative learning, a deep approach to learning, and a preference for reflective learning loaded onto the orientation of Collaborative Knowledge Building in the sample of Swedish medical students (Study III). Similar connections between collaboration and deep approach had earlier been found in an explorative study with Finnish non-medical students (Lonka et al., 2001). The present study shows that similar connections emerge in a population of natural science students from another country, and thus lends support to the links between these aspects of student learning. A confirmatory analysis is in progress, and the results indicate the Collaborative Knowledge Construction Orientation and Cook Book Orientation are robust findings even in a larger Finnish population (Lonka et al., 2008).

The *Collaborative Knowledge Building* orientation differed from the C*ookbook Orientation,* which was defined by a preference for directly applicable knowledge, a surface approach to learning, and dualistic views of the nature of knowledge. This difference may be interpreted as a reflection of the kind of dualistic emphasis that has earlier been found in fields of applied natural sciences. Such an orientation would seem to reflect a wish to acquire unambiguous facts that can be applied to practical problems in a direct, uncomplicated fashion. Such an orientation to learning and studying represents a clear departure from the traditional ideals of academic education, where a deep understanding of issues is a central, defining goal of education (Richardson, 1994).

The skill to collaborate with others in the service of gaining understanding and critical thinking would seem to be useful in learning environments such as problem-based learning, where discussion is used to deepen understanding of central phenomena. In study IV, we found a link between well-functioning small groups and grades in the subsequent course examination. Theoretically, the aim of small group discussions (Norman & Schmidt, 1992; Van den Hurk et al., 2001) would be to encourage deep, reflective, and critical understanding. The link between the functioning of the small group and grades may possibly indicate such a process, where problem-based learning supports high quality, meaning oriented learning. In addition, the results drew attention to the importance of well-designed course materials, such as the cases that are used as triggers for discussion and

learning – highlighting the multi-faceted nature of the contexts where university learning takes place. It would seem to be of utmost importance to foster the quality of small group interaction in collaborative learning environments like PBL.

The comparison between a medical school applying a deep approach to learning and two other medical schools, which had subject-based curricula revealed only small differences, which may appear somewhat unexpected. Medical students from a problem-based program scored slightly higher both on aiming for understanding and on memorization. Several differing explanations of these findings are possible. The results may reflect PBL-students' greater appreciation for seeking understanding and a consequent sensitivity to the demands of the assessment system, which may appear as requiring large amounts of memorization (Lindblom-Ylänne & Lonka, 2001). Another possible explanation might also be that the change in teaching methods from a subject-based, lecture-heavy curriculum to problem-based learning, may not have been accompanied with a matching emphasis on understanding and explanation in assessments. Such a situation could produce a "backwash effect" undermining the influence of the educational intervention (Biggs, 1996). Finally, the ratings for the importance and application of understanding were high in both groups of students. On the whole, students of subject based curricula showed more or less the same levels of deep approach as students in a problem-based program, and the results of the comparison should therefore be regarded as only tentative.

In a recent review, Baeten and colleagues (Baeten, Kyndt, Struyven, Dochy, 2010) recommended that future investigations of student-centered learning environments and approaches to learning should take into account students' perceptions of a number of contextual factors. Based on the existing empirical literature they suggest that the appropriateness of workload, relevance of material for professional practice, students' satisfaction with course quality, supportiveness of teachers, clarity of goals and standards, and appropriateness of assessment should be included. Future investigations should, indeed, venture more and more into the complex dynamics of how students experience problem-based learning in the full richness of context and how such experiences influence their efforts to learn.

3.6 Methodological considerations and future directions

In studies I and III we employed traditional factor analytic methods: maximum likelihood analysis (Study I) and principal components analysis (Study III). In study II, which was started very soon after the material for study I had been analyzed (although finalized at the very end of the whole project), we adopted a more

rigorous, structural equation modeling approach to examine the second-order constructs of deep and surface approaches to learning and their sub-components. The use of structural modeling proved to be useful: The result was a theoretically meaningful and empirically well supported model, which showed stability across differing domains of study. All of the sub-components of both the deep and the surface approaches to learning were theoretically interpretable and empirically supported. In future quantitative investigations, a more extensive use of longitudinal designs, person-oriented approaches, and structural equation modeling is recommended.

The subscale Rote Learning may, at least to some extent, measure a serialist approach to learning, as described by Pask (1976), as the items would seem to refer to a somewhat stepwise, systematic way of studying. If this proves to be the case, the finding that there was a correlation between this particular scale and an intention to understand in the medical sample might become easier to interpret. The subscale Rote Learning may require further scrutiny.

The scales measuring epistemological beliefs focused on the dualistic end of the spectrum. In further studies, it would be useful to expand the scope of measurement. It might be useful to complement questionnaire data with qualitative accounts in order to obtain a richer description of students' understandings of the nature of knowledge and the process of knowing.

In addition, the relations among a deep approach to learning, collaboration, and PBL should be investigated in more detail. The dynamic interplay between the motivational effects of small group learning, the cognitive outcomes of small-group discussion, study orientations, and learning outcomes should be further analyzed. Such an ambitious research program might also benefit from the simultaneous use of quantitative and qualitative methods.

The present study relied heavily on self-report instruments. Qualitative, observational, and experimental studies are needed to corroborate the theory of what constitutes high quality learning in applied natural sciences, such as pharmacy and medicine. In further studies it would also be interesting to investigate how students approach different kinds of content. Would the same students study differently when dealing with different kinds of material (for example, macroanatomy vs. physiology)? Furthermore, would there be interaction between type of material, approaches to learning, and the quality of learning outcomes? Investigating student learning in a variety of well-defined contexts holds promise of providing new understanding of what meaning-oriented, high-quality learning consists of. The important contextual variant of assessment should be analyzed in detail and included in the analyses of what supports high quality learning in various academic programs.

3.7 Conclusion

In the present dissertation, a variety of perspectives were taken in order to better understand the dynamics of approaches to learning and study orientations, in particular in the applied natural science domains of medicine and pharmacy. An attempt was also made to examine contextual variation at several levels: at the rather general level of domains of study, at the level of differing curricula, and between students' general beliefs about how one should go about learning and as contextualized in terms of the task of preparing for examinations. To use the metaphor adopted by Pintrich (2004), student learning was examined at several differing grain sizes. Each perspective afforded a slightly differing view.

From afar, larger patterns of interrelated variables could be seen, whereas a closer look revealed informative distinctions that would otherwise be easily overlooked. On the one hand, narrowly and precisely defined concepts are often appropriate, as they make it possible to look at the considerable contextual and individual variability inherent in real-life learning situations. The SAL tradition of research has at times been criticized for neglecting the richness of higher education students' context-bound experience (Greasley & Ashworth, 2007). When research questions are of a global nature, a large-grain-size approach (Pintrich, 2004) may be useful. Thus, it may at times be fruitful to construct overarching theories, which make a large pattern of interrelated phenomena understandable. Such generalizations may be useful when discussing learning, studying, and educational arrangements with students and teachers. Indeed, the ability to provide educators and developers with usable tools to talk about the objectives and challenges of higher education appears to have been an asset of the SAL tradition of research. Ultimately, the choice of perspective and methodology resides in the researcher and in the nature of the questions driving the inquiry. Noel Entwistle talks about these choices and the challenges involved:

> *"Differing conceptions are triggered by differing situations. A unifying theory that would take into consideration the cognitive and the contextual perspectives and explain how conceptions actually are triggered by contexts does not yet exist" (Entwistle, 2007, p. 139).*

The present dissertation did not take upon itself the task of creating such a comprehensive theory of student learning. The aim was, instead, to shed light on the great contextual and individual variability found within these interrelated phenomena. In the future, it will be important to use richer methodological tools to see beyond the findings of the present dissertation. In the meanwhile, the present dissertation managed to shed light on some novel dimensions of the phenomena

of interest in the SAL tradition. Understandings of deep and surface approaches to learning were enriched by examining their linkages to epistemologies and collaborative activity. New ideas for measurement were introduced. These findings may be considered as new working theories to be tested, clarified, and scrutinized by future research.

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